

newscientist



RESEARCH IN THE NATIONAL HEALTH SERVICE

Pollution beneath the Golden Gate
Supermembranes • Indochina's forest ox

SCIENCE 88

The 150th Annual Meeting of the

British Association for the Advancement of Science

OXFORD 5-9 SEPTEMBER 1988

*A festival of science and technology for people of all
ages and interests*

★ Monday is Family science day with talks, careers information, workshops, trails, films and exhibitions for all ages. Sir Walter Bodmer will give his Presidential Address in the evening
★ Tuesday highlights Evolution ★ On Wednesday Molecular electronics and science education head a double bill ★ The Parliament of Science debates science policy in the UK on Thursday ★ Biotechnology is in the spotlight on Friday
★ A scientific film festival, a scientific amusement arcade, a science in business and industry exhibition and visits to places of scientific and general interest in the Oxford area will run throughout the week
★ And much, much more besides!

Science 88 in Oxford is not to be missed!

For further details write to:

**Dr Connie Martin, BAAS, Fortress House, 23 Savile Row,
London W1X 1AB, England**

Camera Press



Stumbling over the Mars bar, p 40



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This week's cover by Bill Sanderson. Forty years on, but still on the waiting list: research in Britain's National Health Service, p 54



NEXT WEEK

Computers plot the way of the fire

Detecting fires is one thing, finding out how they spread is another. Researchers are using computer models to get you out alive

Breeding with genes

Law in orbit

The day of the rhododendron

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Uphill battle to save Filipino trees

When Marcos was President, foresters ransacked the Philippines for wood to sell to Japan. The new government wants to replant the forests before the soil washes away

Debora MacKenzie

Fighting for the forest ox

Earlier this century, scientists discovered the primitive kourpey in the forests of Indochina. It could help to make domestic cattle resistant to disease—if it survives

Elizabeth Kenf

Research begins at forty

Since it was created in 1948 Britain's National Health Service has hardly contributed to research. But this could change. New proposals could give it a second chance

Richard Smith

Pollution beneath the Golden Gate

One of the world's largest and most beautiful estuaries is also one of the most polluted. Will Californians save their bay?

Miranda MacQuitty

The membrane at the end of the Universe

In the quest for the ultimate theory of everything, theorists have given superstrings another dimension. Supermembranes may wrap up the Universe in 11 dimensions

Michael Duff and Christine Sutton

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Life, the Universe and (almost) everything

Ariadne

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Shift working may be required from time to time.

Last date for the receipt of completed applications: 14th July, 1988.

Application forms and further details from: Personnel Dept., P.M.S.U., Civic Centre, Darwall Street, Walsall WS1 1TP, quoting job title and reference number.

Telephone: Walsall 650000 ext. 3202.

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A Materials Engineer is required to lecture on undergraduate, postgraduate, HND and HNC courses in production, mechanical and (occasionally) civil engineering courses.

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Active encouragement is given to those wishing to undertake consultancy work, to register for a higher degree and to organise special short courses.

Further details and form of application available from:-

The Personnel Office, Trent Polytechnic, Burton Street, Nottingham NG1 4BU. Tel (0602) 418248 Ext 2148.

Closing date 11 July, 1988. Please quote post reference number G0473.

WEST YORKSHIRE HIGHWAYS, ENGINEERING AND TECHNICAL SERVICES JOINT COMMITTEE

West Yorkshire Highways, Engineering and Technical Service Joint Committee (HETS) has been established to provide specialist professional services to the Five District Council in West Yorkshire. In addition we offer similar specialist cost-effective services to other organisations.

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TECHNICIAN UD 1822 (3)

Scale 3/4 £7122-£8754

A Technician is required to undertake the sampling and chemical and physical testing of a wide range of construction and related material in our Laboratory in Ossett.

Ideally applicants should hold, or expect to obtain this year, ONC/BTEC or similar qualification in Chemistry, and have a minimum of three years experience in modern techniques of chemical analysis. A current driving licence is desirable.

Application forms can be obtained by writing, enclosing a large SAE to the Personnel Officer, Highways, Engineering and Technical Services, Selectapost 6, Dudley House, 133 Albion Street, Leeds or by telephone on Leeds 462608.

Closing date: 18 July, 1988.

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£10 359 pa to start

The Department of Psychology is seeking to appoint a Technician (Grade 6) under the NAB Selective Initiatives Scheme.

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Suitable candidates are likely to be graduates in Psychology with experience in programming to a level necessary to meet the requirements of the job: i.e. the provision of software for applications such as laboratory class practicals and student/staff projects.

Alternatively, someone with applications programming experience, with an interest in the behavioural sciences, or developing such an interest would be seriously considered.

For further details of this interesting new job write on a postcard to the Recruitment Officer, City of London Polytechnic, 117-119 Houndsditch, London EC3A 7BU; quoting reference number 88/43.

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We are positively committed to a policy of equal opportunity for all. We look forward to receiving suitable applications from all sections of the community which will be considered on merit, regardless of sex, age, race, ethnic origin, marital status, responsibility for dependents, sexual orientation or disability.

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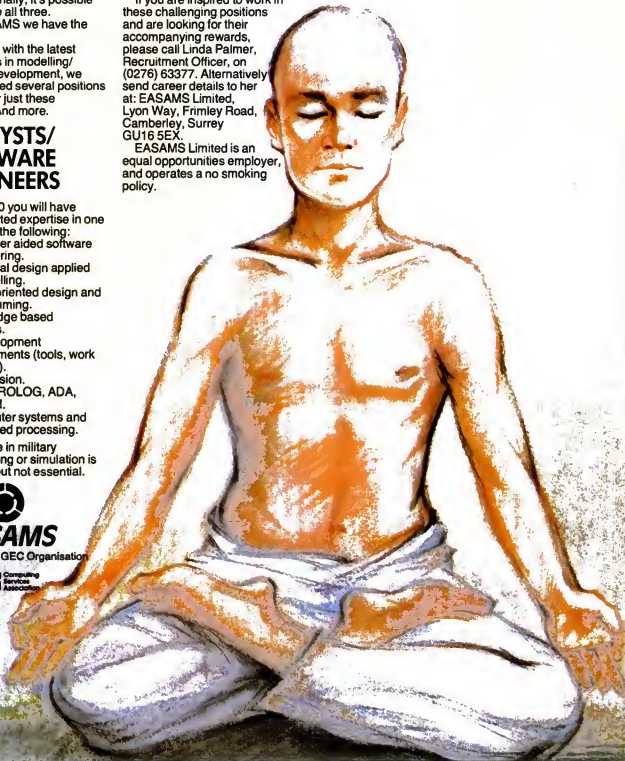


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Aged 30-40, you must have a PhD in Chemistry, Biochemistry or Chemical Engineering plus at least five years' experience in either a pharmaceutical,

medical instrumentation, plastics or high technology ceramics environment. Sound man-management skills will be enhanced by well-developed communication abilities.

In return, there's an excellent salary and benefits package, including assistance with relocation where necessary and, above all, outstanding career opportunities with a progressive organisation.

Interested? Please telephone Barrie Witt on 021-456 1385 (office hours) or 06845 66477 (evenings) or write with full CV quoting Ref. LS 839 to Austin Knight Selection, Tricorn House, 51-53 Hagley Road, Edgbaston, Birmingham B16 8TP.

Austin Knight Selection

UNIVERSITY OF SURREY

Department of Electronic & Electrical Engineering
Power Electronics for Space Applications
RESEARCH FELLOW

Applications are invited for a Research Fellow to work in broad-based research on advanced DC-DC conversion techniques for spacecraft. One application is power supplies for satellite ion thrusters. The research will include theoretical and simulation studies as well as experimentation.

Applicants should hold a good degree, and a higher qualification would be welcome. Ideally an electronics or physics background would be combined with a practical bias and a strong ability to grasp fundamental principles.

The contract will be for three years initially, at a starting salary of up to £16 545 per annum depending on qualifications and experience. The successful applicant will join a growing research group in a thriving department.

An informal discussion or visit can be arranged by telephoning Mr B. Hamill on Guildford (0483) 509122. Applications in the form of a cv (three copies) including the names and addresses of two referees, should be sent to the Personnel Office (JLC), University of Surrey, Guildford, Surrey GU2 5XH quoting Ref 721. The closing date is 22 July, 1988.

UNIVERSITY OF NOTTINGHAM

DIRECTOR OF WORKS DESIGNATE

The University seeks a Director of Works Designate with effect from 1 January, 1989, who will become Director on 1 September, 1989, following the present Director's retirement. The University of Nottingham is a community of over 10 000 staff and students. The campus extends to 330 acres, with extensive teaching, research and living accommodation. The School of Agriculture is 11 miles away and the department is responsible for other properties in the Nottingham area.

The Director of Works is responsible to the Bursar for the planning, construction and maintenance of the University estate. Capital works, Engineering and Maintenance are the major sections reporting to the Director. The Director Designate will initially head the Capital Works Section.

The appointee will be professionally qualified. Whilst there may be preference for a Chartered Surveyor or Quantity Surveyor, applications from Architects, Chartered Engineers or similar professions will also be considered. Applicants should have extensive experience, probably gained within the Construction Industry, of the management of Capital and Revenue Budgets, and of manpower. Experience in Universities, Industry or the Public Sector will be equally relevant, provided a successful and innovative track record can be demonstrated over a considerable period. Starting salary £22 245 pa with transfer to Administrative Grade 6 salary scale on appointment as Director.

Further particulars and application forms can be obtained from The Personnel Office, University of Nottingham, University Park, Nottingham NG7 2RD. Closing date is 31 July and interviews will take place during September. Tel 0602 484848, Ext 3355. Ref 1164.

THE LEPETIT RESEARCH CENTER

is part of the Merrell Dow Research Institute, the Research & Development function of Merrell Dow Pharmaceuticals, Inc. of Cincinnati OH, USA.

The Lepetit Research Center is devoted to discovery, characterisation, development of novel anti-infective agents and is located in Gerenzano (Italy) some 30 Km north of Milan.

We are looking for a: MICROBIAL TAXONOMIST/PHYSIOLOGIST

to actively participate in programmes of isolation and culture of novel microorganisms as a potential source of bioactive molecules

The ideal candidate has the following qualifications: PhD in a microbiological discipline, preferably with expertise in isolation and characterisation of rare actinomycetes and/or gliding bacteria; a solid knowledge of microbial biochemistry and genetics; a minimum of a two-year postdoctoral experience; publications in relevant journals.

We offer: a competitive initial salary, a salary progression based on "pay for performance" philosophy; a liberal publication and congress participation policy; a multidisciplinary, multinational environment; contribution to moving expenses, if appropriate. Knowledge of Italian is not essential.

Applications including a detailed cv and list of publications should be sent to:

Lepetit Research Center, Selection Manager Via R. Lepetit, 34, 21040 Cerenzano (VA) Italy.

ST GEORGE'S HOSPITAL MEDICAL SCHOOL

(University of London)

Department of Medicine II RESEARCH TECHNICIAN

required to join an active Cancer Research Campaign funded laboratory investigating the expression of growth factors in human breast cancer.

The successful candidate will be expected to work closely with other members of the group on a project involving immunocytochemistry, localisation in breast biopsies of various peptide growth factors, particularly TGF-beta and prolactin receptors using newly developed monoclonal antibodies. There will be interaction with ongoing work studying expression at the nucleic acid level.

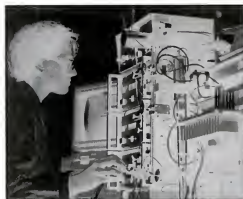
Applicants should have previous experience in immunocytochemistry and be familiar with histological techniques. Knowledge of breast cancer would be an asset but is not essential.

Salary up to £9662 pa (including London Allowance), depending on experience and qualifications.

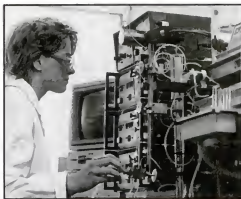
Informal enquiries welcomed to either Dr Charles Chamberlain, Dr Yunus Lachgar or 01-872 4565.

Applications including full cv and two referees should be sent to The Personnel Officer, St George's Hospital Medical School, Cranmer Terrace, Tooting, London SW17 0RE. Quote Ref. No 98-68. Closing date 21 June, 1988.

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Please write with full cv to Mrs Julie Moore, Personnel Department, Chemicals Division (CB3), Rhône-Poulenc Ltd, Rainham Road South, Dagenham, Essex RM10 7XS.



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—Effects on Buildings: to investigate the impact of airborne particulate matter on buildings. All projects involve close collaboration with major industrial and public sector organisations. Salary in the range £4000 to £10 000 pa.

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Dr R. Hamilton (Ref C431C, Middlesex Polytechnic, Queensway, Enfield EN3 4SF, Tel 01-368 1299. Closing date 6 July.

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Qualifications: You will need a degree or equivalent in Biology or Zoology with an emphasis in entomology or invertebrate zoology. A sound knowledge of at least one major order is required.

Salary: Depending upon experience and qualifications.

Scientific Officer: £8284-£10 622.

There may be further vacancies within the Chief Scientist Directorate also based in Peterborough.

Application forms and further details are available from Personnel 1, Nature Conservancy Council, Northminster House, Peterborough PE1 1UA. Closing date for completed forms is 21 July, 1988. Please quote Ref HE2 36 116.

The NCC is an Equal Opportunities Employer.

UNIVERSITY OF BATH Schools of Chemistry and Chemical Engineering

Membranes for Gas Separation

A vacancy exists for a
RESEARCH EXPERIMENTAL
OFFICER

to carry out a one year feasibility study into the development of novel membranes for gas separation. This work, which is part of a large programme on novel materials, is financed by a major British company. The successful candidate will become part of an existing team consisting of three academics and two postdoctoral researchers. The post is suitable for a graduate student and will involve primarily synthesis and characterisation of organofunctionalised polymeric materials, followed by gas permeation measurements.

Salary will be in the range of £8675-£9665 pa.

Application forms from the Personnel Office, University of Bath, Claverton Down, Bath BA2 7AY or Tel Bath 826095 quoting Ref 88/148.

Closing date 15 July, 1988.

Informal contact may be made with Dr B. J. Bridson or Dr A. J. Ashworth, School of Chemistry, Tel Bath (0225) 826826 Ext 8517 or 6103, or Dr R. England, School of Chemical Engineering, Tel Bath (0225) 826826 Ext 5516.



SCIENTISTS AND ENGINEERS

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Preparation of a UK underground test in Nevada

... and downs.



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- o Materials Scientists
- o Computer Scientists

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Starting salaries are up to £17,000. (Salaries will be reviewed with effect from 1 August 1988). We expect you to have a degree, or HND/HNC and relevant experience. In addition to full-time appointments opportunities also exist for part-time employment and fixed period appointments.

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For further details please write to the Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours) for an application form, to be returned by 29 July 1988.

For Engineer vacancies please quote ref: T(11)85/15
For Scientist vacancies please quote ref: S(1)29/DAWE/15

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Positions are available for analysts in the Specialities and the International Development teams. The ideal candidates will be recently qualified Chemistry Graduates, (or GRSC). Some relevant experience will certainly be useful but is not absolutely essential.

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We also have opportunities in the Formulation/Development sections of the International and Generic Development teams. The ideal candidate will be young Science Graduates, Pharmacists or persons with experience or a qualification in a related field.

Starting salary will reflect age and experience and we are offering an excellent benefits package, including relocation assistance where appropriate, 25 days annual holiday, a 36½ hours week, Company Pension Plan and Life Assurance.

If you are looking for a challenging and stimulating position with potential please send a detailed C.V. or telephone for an application form to:

Mr Alan Stobbs, Personnel Officer, St. Leonards House,
St. Leonards Road, Eastbourne, East Sussex BN21 3YG.
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Public Health Laboratory Service Board

Department of Virology
MLS OR JMBLSO GRADE

There will shortly be two full time vacancies primarily suitable for holders of an HNC/HND in MLS (Microbiology) or appropriate science degree who are registered with the CPSP. (JMBLSO grade open to candidates with an ONC/TEC in MLS, or appropriate science degree acceptable to the CPSP).

A broad training in Microbiology is desirable since there will be opportunities to participate in the on-call service and routine work of Bacteriology.

Virology is a progressive department, handling about 36,000 specimens per year and offering a very comprehensive diagnostic service which includes full Serology.

Successful candidates will be actively supported in pursuing further relevant education in Virology.

MLS salary scale is currently £6686-£9435.

For further information and informal visits please contact Mr J. McKenzie, SCMLS, Tel 0734 863115.

Application forms and job descriptions from Mr B. Walsh, FMLSO, Tel 0734 861957, Ext 33.
Closing date: 15 July, 1988.



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THE BRITISH INDUSTRIAL BIOLOGICAL RESEARCH ASSOCIATION

MANAGING EDITOR

BIBRA is an internationally recognised research institute financed by government and industry and engaged in research into the safety of chemicals used in food, medicines and the environment.

We are seeking a managing editor for an international toxicological journal. This is a position of considerable responsibility, and requires the management and editing of scientific manuscripts from submission through to publication. Applicants should be graduates in the biological sciences or chemistry and should have at least two years' experience in science editing.

The salary will be according to age and experience. Other terms and conditions of employment include 25 days' annual leave, flexible working hours, pension and life assurance benefits and free transport from Sutton and Carshalton Beeches stations.

Written applications, including a cv, should be sent to the Personnel Officer, BIBRA, Woodmansterne Road, Carshalton, Surrey SM5 4DS.

Research Leader - Chemical Analysis

£15-22K + bonuses

Glaxo Group Research, part of Britain's largest ethical pharmaceutical group, is entering a new phase of growth and has a vacancy for an experienced chemist to lead a team of five analysts who provide support to research staff involved in the development of processes for preparing new drug substances.

To be considered for this challenging post you will need to demonstrate that you have: a proven track record in method development and problem solving; an ability to work alongside organic chemists, pharmacists and other analysts; and personal skills to both lead and motivate a team and manage a laboratory.

As a senior scientist you will receive a salary to reflect your experience, very generous bonuses, a non-contributory pension, 25 days' holiday, work flexible hours, and be able to make use of our subsidised cafeteria and sports facilities. Relocation assistance will be provided where appropriate.

To apply please telephone for an application form or send a CV to Alan Garmonsway, Senior Personnel Officer, Glaxo Group Research Limited, Greenford Road, Greenford, Middlesex UB6 0HE. Telephone 01-422 3434, extension 2573 quoting reference number 140.

Glaxo Group Research Ltd.



Smith & Nephew Pharmaceuticals is part of the highly successful Smith & Nephew Group of Companies and specialises in Ophthalmic and Dermatological products.

DEPUTY MICROBIOLOGY DEPARTMENT MANAGER

An experienced graduate Microbiologist is required to lead a team of Microbiology Technicians in the Quality Assurance Laboratory. Team leaders in the department are responsible for all aspects of microbiological testing of a specific range of pharmaceuticals.

The successful candidate will deputise for the Department Manager in his absence, and may be offered training towards qualified person registration, if required.

TECHNICIAN

In addition Technicians are required to undertake product and process assessment within the Microbiology Department. Candidates should preferably possess two 'A' levels, one in a Biological subject, and be aged between 18-25 years.

Salary for both posts is according to age and experience, benefits include 5 weeks holiday, and company pension scheme.

If you enjoy working in a challenging environment and wish to join our Quality Control Team, please write for an application form to: Mr. Len Dorrell, Divisional Personnel Manager, Smith & Nephew Pharmaceuticals Limited, Bampton Road, Romford, Essex RM3 8SL.

Smith+Nephew

Science and Engineering Research Council

CAREERS IN SCIENTIFIC ADMINISTRATION

The Science and Engineering Research Council encourages and supports research and advanced training in science and engineering by:

- funding research programmes in universities, polytechnics and its own establishments;
- providing national and international facilities for research scientists;
- providing postgraduate studentships.

The Council is advised by Boards and Committees of specialists from the academic world and industry who formulate policy and assess the scientific merit of research proposals.

Vacancies now exist in SERC's Swindon Office for Scientific Administrators who will usually work as part of a team in a Committee Secretariat.

Committee Secretaries play an important role in advising applicants for SERC support, identifying scientific priorities and policy options and evaluating programmes. Also they liaise with and visit universities, polytechnics, industrial and Government R & D establishments.

Candidates should be able to demonstrate a flair for administration, the ability to communicate effectively with professional people of all levels, and the desire to develop their knowledge and interest in subjects beyond their particular disciplines, in which they will often need to become scientifically literate.

The successful candidates will have:

For **Scientific Officer**: a 1st or upper 2nd class Honours degree in a scientific, mathematical or engineering subject.

For **Higher Scientific Officer**: a 1st or upper 2nd class Honours degree with a minimum of two years' postgraduate industrial or academic experience.

The starting salary for the SO grade is £9687 p.a. rising by annual increments to £10622 p.a. The salary scale for the HSO grade is £9687 to £13005 p.a.; starting salary depends upon qualifications and experience. There is a generous annual leave allowance plus 10 days for public and privilege holidays.

Application forms are available from the address below and should be returned by **15 July 1988**, quoting reference NS/4.



Personnel Section,
Science and Engineering Research Council,
Polaris House,
North Star Avenue,
Swindon,
Wiltshire, SN2 1ET.
Telephone: (0793) 26222 Ext 2111.

ANIMAL TECHNICIAN

A vacancy exists for an Animal Technician in a London Medical Research Council Unit.

Duties will include animal husbandry, involvement in the maintenance of a containment facility and the opportunity to assist with experimental procedures.

Previous experience, together with an IAT qualification, is desirable but candidates without previous experience who are interested in a career in animal technology are invited to apply.

Salary, according to age and qualifications, in the range £2534 (age 18) to £7887 p.a.

Telephone for an application form and further details to Jacky Wood, Personnel Officer (telephone No 01-740 3162). Closing date: Two weeks.

The Medical Research Council is an equal Opportunity Employer.

THE QUEEN'S COLLEGE GLASGOW

1 Park Drive, Glasgow G3 6LP Tel: 041-3348141

LECTURER IN FOOD SCIENCE/FOOD PRODUCT DEVELOPMENT

Department of Applied and Life Sciences

Salary Scale: £9750-£17 499

Applications are invited from persons with appropriate qualifications to teach the subjects on degree and diploma-level courses.

Further details may be obtained from the Secretary and Treasurer at the above address.

Closing date for receipt of applications is 29 July, 1988.

A Scottish Central Institution.



PUBLIC HEALTH LABORATORY SERVICE BOARD

PHLS Centre for Applied Microbiology & Research
Division of Biologics
Safety in Biotechnology

An interesting vacancy for a
BASIC GRADE
MICROBIOLOGIST

exists within the framework of the new Industrial Biosafety Project and joint CAMR/DTI Warren Spring Laboratory venture aimed at providing the biotechnology industry with scientific information and services relating to the safe microbiological operation of biotechnology equipment and processes. This post will be concerned primarily with scientific assessment of the microbiological safety of biotechnology equipment and processes and other topics of interest to club members.

You will be a graduate or a post-graduate with an interest in industrial biotechnology, microbiology or aerobiology.

Appointment initially for a three year period.

Salary scale: £7825-£10 496 p.a.

NHS terms and conditions.

Further information from Dr P. Hambleton or Prof J. Melling. Tel (0980) 610391.

Application forms from the Personnel Officer, PHLS Centre for Applied Microbiology & Research, Porton Down, Salisbury, Wilts. SP4 0JG. Tel (0980) 6120391.

Closing date: 21 July, 1988.

Quote Post No 0503.

ROYAL FREE HOSPITAL

The Haemophilia Centre and Haemostasis Unit

Pond Street, London NW3 2OG
(Tel 01-794 0506, Ext 4229 or 4207)

SENIOR MEDICAL LABORATORY SCIENTIFIC OFFICER

Salary £9664-£12 778 p.a. inclusive of London Weighting.

Applications are invited from state registered holders of the Fellowship of the IMLS with the Special examination in Haematology.

The Haemophilia centre is one of the largest, most active of its kind in the world providing clinical, laboratory and administrative services for adults and children with bleeding and thrombotic disorders living in a wide area of South East England.

The successful applicant will be expected to assist the Chief MLSC in the supervision of the routine service section of the laboratory and assist in training of other staff. The post offers a wide range of experience and participation in out of hours duties is available.

Applicants should have had extensive relevant experience although comprehensive training will be given.

Informal visits are encouraged. More information, job description and application form may be obtained from Mr D. J. Bone SCMLSO at the above address. Closing date Monday 11 July, 1988.

From process development to production:

Opportunity for high-achieving young engineer/scientist

From £23,000 + benefits

Pedigree Petfoods is the established leader in its highly competitive consumer market sector, producing a range of well-known brands including the UK's biggest-selling grocery line. We are, as ever, determined to maintain and enhance our superiority into the 1990s and beyond: continuous R&D effort backed by substantial investment in new technology is already ensuring that we succeed in this key objective.

As part of our ambitious development plans, we seek a creative young graduate engineer or scientist to assume the day-to-day control of a high-priority, state-of-the-art process development project which is expected to generate benefits throughout the international Mars Group. You will be responsible for directing a diverse team of technicians engaged on trials programmes; commissioning and ensuring the smooth running of the pilot-plant line; managing production for test-marketing; and subsequently contributing to the development of the full-scale manufacturing line. Considerable interaction with other business functions and external suppliers will be involved.

In effect, you will be "running your own show" — which means your progress will be closely linked to the success of the project. The rewards for achievement will be considerable: opportunities for rapid personal growth

could extend into R&D, manufacturing management, or more widely into other disciplines or companies within the Group.

We want to hear from energetic young chemical engineers or physical scientists working in continuous-process industry, whose innovative technical solutions over 3-8 years have involved significant departure from previous practice and already yielded substantial commercial advantages: we'd stress that it's the **QUALITY**, rather than the length, of your contribution that's of interest to us. Tenacity, personal impact and the ability to make things happen in a fast-paced environment are among the key personal qualities sought; it follows that proven man-management experience would be a strong recommendation.

A wide range of non-contributory benefits will include comprehensive assistance with a move to the rural East Midlands — an attractive area offering many lifestyle advantages — if appropriate.

To find out more, call 0476 64253 (line manned 8am-5pm, Mon-Fri). Do not send a cv at this stage. Closing date for receipt of completed applications: 18th July 1988.

We welcome applications equally from women and men.

**Pedigree
Petfoods**



Peptide and Protein Purification

An opportunity exists for a biochemist/chemist in the area of protein and peptide purification.

We are seeking to recruit a young graduate with a good honours degree and possibly some experience of peptide and protein purification.

Applications including a detailed cv should be addressed to:

**Peninsula Laboratories Ltd, PO Box 62,
17K West Side, Jackson Street, St
Helens, Merseyside WA9 3AJ.**

**ROYAL BOTANIC GARDEN
INVERLEITH ROW
EDINBURGH**

HIGHER SCIENTIFIC OFFICER (PHOTOGRAPHY)

Applications are invited for the post of Higher Scientific Officer in the Photography Department.

The successful candidate will be required to take overall responsibility for the financial and operational management of the Photographic Department.

QUALIFICATIONS:

Previous experience in a wide range of photographic techniques with some recognised certification, eg City & Guilds, is essential. An interest in biological or natural history photography is also essential. A particular interest in audio-visual systems would be an advantage.

SALARY:

On Higher Scientific Officer scale £9687-£13 005 with salary according to qualifications and experience.

Application forms and further information may be obtained by writing to the Personnel Department, Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR.

The closing date for receipt of completed application forms is 22 July, 1988.

PHARMACOLOGY— NEW GRADUATE

Research

Edinburgh

- * New compound evaluation
- * Learn new techniques
- * Pharmaceutical research and development

Due to expansion, we have a vacancy for a new honours graduate in Pharmacology to work as part of a small team using advanced methodology. Syntex Research Centre is part of the multi-national Syntex Corporation. We are actively involved in the research and development of new compounds in the cardiovascular and CNS areas.

Modern custom-built laboratories on a university campus on the outskirts of Edinburgh. Conditions include 37 hour week, Luncheon Vouchers, bonus opportunities, non-contributory pension, and free medical insurance.

If you want to be involved in exciting research using up-to-date techniques, write for an application form to:

MR A. B. CRAN
DIRECTOR OF PERSONNEL
SYNTAX RESEARCH CENTRE
HERIOT-WATT UNIVERSITY
RICCARTON, EDINBURGH EH14 4AS

SYNTEX
Research Centre

UNIVERSITY OF EAST ANGLIA
Norwich
SCHOOL OF ENVIRONMENTAL
SCIENCES

Senior Research Associate

Required to work with Professor L. E. J. Roberts in the Environmental Risk Assessment Unit, and with Professor T. M. L. Wigley and Dr R. A. Warrick in the Climatic Research Unit, on interdisciplinary projects to study the possible impacts of climatic change. The post will run from September 1988 for two years in the first instance. Part of the work involves developing models for estimating how policy decisions could affect the probabilities of future climatic change. A specific project concerns estimates of sea level rise due to the "greenhouse effect" and environmental impacts in the UK. Applicants therefore should have broad interests in risk assessment and should possess skills in computer modelling. A higher degree in climatology, meteorology, physical geography, mathematics, statistics, physics or environmental sciences is appropriate. Appointment will be on the 1A scale with a starting salary in the range of £9865 to £12 760. Applications, containing full cv and the names, addresses and telephone numbers of three referees, should be sent by 13 July, 1988, to Dr J. P. Darch, Research Administrator, Climatic Research Unit, University of East Anglia, Norwich NR4 7TJ (0603 592994). Further particulars are available from Dr Darch. Specific enquiries about details of the project should be made to Professor L. E. J. Roberts (0603 592547).

EXPERIMENTAL OFFICER FIELD TESTING SECTION

Jealott's Hill is the focal point for ICI Agrochemicals' research and development where intensive field testing plays a vital part aiding the discovery of plant protection products for use on a worldwide scale.

As a graduate in an agricultural or biological subject, with an interest in microbiology and plant pathology, you will be responsible for the organisation and reporting of field trials directed towards evaluating the effects of micro-organisms on plant pathogens. Initially, you will be based in our Plant Pathology team within the Field Testing Section although there are excellent career prospects at team leader level at Jealott's Hill or in a more commercial field—as well as the opportunity to gain overseas experience.

You should have good communication skills and the ability to work in a team. A knowledge of micro-computers is an advantage. A driving licence is essential.

We offer an attractive salary and a wide range of benefits including pension and profit sharing schemes and a lively recreation club.

Please send your cv, to Miss Karen Grant, Recruitment Office, ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berks RG12 6EY.

Please quote reference: FTS3.

Closing date: 15th July.

ICI is an equal opportunities employer.



Agrochemicals

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SOUTH BANK POLYTECHNIC
Centre for Systems and Software
Engineering

Department of Electrical and
Electronic Engineering
British Telecom International
RESEARCH ASSISTANT/
FELLOW IN INFORMATION
TECHNOLOGY

Applications are invited from psychologists, sociologists, or computer scientists for a research position supported by British Telecom International. To investigate user requirements for computer systems. The aim of the project is to gain a better understanding of the process whereby user and contractor establish the requirements for a system and how these are translated into an operational system.

Candidates for the post at Research Assistant level should have a good honours degree, or the equivalent, in a relevant subject, combined with a willingness to cross inter-disciplinary boundaries, and would be expected to register for a higher degree. Candidates for the post at the Research Fellow level should have a PhD in psychology or the social sciences. Applications from candidates with a multidisciplinary background would be particularly welcome.

The appointment would be for two years initially and would be on either the Research Assistant Scale (£8179-£9228 inclusive) or the Research Fellow Scale (£11 359-£12 418 inclusive), according to qualifications and experience. Starting date: 1 September, 1988, or as soon as possible thereafter.

Application forms and further details are available from the Personnel Department, South Bank Polytechnic, Borough Road, London SE1 0AA. Tel 01-928 3512 (answering service 9.00am-5.00pm). Informal enquiries about the post may be made to Dr Graham Richardson. Tel 01-928 8989, Ext 2352.

Please quote Ref EX18.
Closing date 22 July, 1988.

An Equal Opportunities Employer.

UNIVERSITY OF READING
Department of Microbiology
A POSTDOCTORAL
RESEARCH FELLOW

is required for a three year project starting 1 October, 1988 as part of the SERC's membrane initiative. The project is to assess the molecular signals required for protein targeting/sorting during the biogenesis of the glyoxysome in *Neurospora crassa*, by the use of specific induced mutations and gene fusions or cloned glyoxysome specific genes. Candidates with experience in recombinant DNA technology and/or membrane biochemistry should apply in writing with full cv and to Dr J. F. Conerton, Department of Microbiology, University of Reading, London Road, Reading RG1 5AQ. Please also (apart from overseas applicants) apply for an application form to Personnel Officer, University of Reading, Whiteknights, PO Box 217, Reading RG6 2AH. Tel (0734) 875123, Ext 233. Please quote Ref R41.

Professional training in Intellectual Property

In four years time would you like to be a newly qualified Chartered Patent Agent/European Patent Attorney, with experience of working in a large multinational company and the ability to handle intellectual property problems in the fields of computer hardware, software and peripherals?

This career opportunity leads to the Professional Qualifications of Chartered Patent Agent and European Patent Attorney. The job involves a wide-range of Law and Technology. The training is given by a fixed-term four year contract within the Intellectual Property Department of IBM based in Winchester, which has national and international responsibility for Intellectual Property.

Intellectual Property has become critically important to British Industry, particularly in the field of information technology. The protection of inventions, prevention of illegal copying of

software and the licensing of technology has highlighted industry's need for skilled professionals.

Full training will be given and the successful applicant will be expected to undertake a part-time course of study, leading to the European Patent Attorney qualification, including study at Queen Mary's College, London.

Applicants should also have the personal qualities and background to handle both the legal and wide ranging technical facets of the work, plus an honours degree in science, engineering or mathematics.

Please write enclosing full career details to Beverley Bradford, IBM United Kingdom Limited, PO Box 41, North Harbour, Portsmouth, Hants. PO6 3AU.

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- An equal opportunity employer
- £1,837 million exports in 1987

IBM

Department of Physical Sciences and Computing
and
Department of Electrical and Electronic Engineering

Researcher A

£8106-£9165 Ref: RAEE

Researcher B

£11 286-£14 466 Ref: RBPSSC

These posts are tenable in the first instance for one year, with the possibility of extension for two to three years to work with Dr A. K. M. M. Haque and Dr J. Yates in an established programme of research on the susceptibility of high density MOS devices to radiation and their application in dosimetry.

Researcher A: The candidate should have a good honours degree in Physics, Electronics or its equivalent.

Researcher B: The candidate is expected to have a PhD (or to be shortly awarded) in Physics or Electronics.

Preference will be given to candidates having experience in scientific computing, digital electronics or microprocessor interfacing. Knowledge of simulation techniques, radiation dosimetry and the effects of radiation on biological and other materials will also be advantageous.

Application forms and further details are available from the Personnel Department, South Bank Polytechnic, Borough Road, London SE1 0AA. Tel: 01-928 3512 (answering service 9.00am to 6.00pm). Please quote relevant reference number.

Closing date: 14 July, 1988.

An Equal Opportunities Employer



STUDY DIRECTOR— BIOANALYTICAL CHEMISTRY

Inveresk Research International Limited (IRI) is an expanding independent contract research organisation of outstanding reputation, which is located close to Edinburgh in a highly desirable area, offering many amenities and outdoor pursuits.

A specialist in chromatographic separation techniques applied to quantitative analysis of drugs and metabolites in biological fluids, is required to work in our Analytical Chemistry Department. Candidates should be qualified to PhD level, should be familiar with a range of chromatographic and data handling equipment and should be capable of supervising the work of junior analytical staff.

The Company offers a range of benefits associated with a modern and progressive employer which include competitive salaries, free private medical cover, bonus schemes, relocation assistance package (where appropriate) and membership of the Company's Pension and Life Assurance Plan.

Candidates should forward a full CV, giving an indication of current salary, to the Personnel Department, Inveresk Research International Limited, Inveresk Gate, Musselburgh EH21 7UB, quoting reference number 1425.



Hoggett Bowers

Executive Search and Selection Consultants

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A MEMBER OF BLUE ARROW PLC

Head An Organic Analysis Team

**Advanced Industrial Materials Business
Middlesex,**

Up To £20,000

Broad background experience is required, in techniques covering simple and complex organics. You will also need some experience of synthetic organic chemistry, plus good communication skills, and the ability to manage people and major analytical projects.

The team services and supports research and development work being carried out for a large "top 100" British company, including electronics materials, processing chemicals, polymers/plastics, photoactive materials, and organic resins.

Many very varied and challenging projects are in hand. The team is being expanded from the present six people to ten. The facilities are extremely well-equipped for advanced analytical work.

Experience in several of the following is essential:— nuclear magnetic resonance, Fourier transform infra-red spectroscopy, gas-liquid chromatography, high performance liquid chromatography, gel permeation chromatography and ultra violet spectroscopy.

Male or female candidates should submit in confidence a comprehensive c.v. or telephone for a Personal History Form to, **D. Venables, Hoggett Bowers plc, 1/2 Hanover Street, LONDON, W1R 9WB, 01-734 6852, quoting Ref: H15041/NS.**

Senior Development Engineer

Northern Home Counties

LINK

State-of-the-art technology and massive investment in R & D has kept this major multinational company ahead of the competition.

This important position requires a graduate capable of designing and developing control systems from specifying the optical/magnetic sensors to defining the algorithms and carrying out the resulting software de-bug. You will also be involved in the design, build and running of computer-controlled rigs.

With a degree in a Physics/Electrical/Electronic discipline and at least two years relevant experience, applicants must have knowledge of digital and analogue electronics. Computer literacy—ideally with knowledge of Assembler—is essential.

Salary is negotiable and the company offers comprehensive benefits and generous relocation assistance. There are further prospects with an organisation firmly committed to career development.

Please contact Sue Skidmore, Link Management Services, 508 Elder House, Elder Gate, Central Milton Keynes MK9 1JJ. Tel: 0908 560232.

AFRC INSTITUTE OF ARABLE CROPS RESEARCH

Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ

HIGHER SCIENTIFIC OFFICER—PLANT BIOCHEMISTRY

This post is part of a major multidisciplinary research initiative on the development of novel plant compounds and biological agents against pests and pathogens of oilseed rape. Several new posts have been created in the Department of Biochemistry, Entomology and Nematology, Insecticides and Fungicides and Plant Pathology to develop systems of crop protection that will lead to zero pesticides residues in oilseed rape.

The person appointed will initiate studies of the biosynthesis of glucosinolates in Brassica spp and its regulation. The work will involve enzyme purification and assay and the isolation and characterisation of glucosinolates and intermediates in their biosynthesis. Induced mutants with lesions in the pathway of glucosinolate biosynthesis will also be identified and characterised.

Qualifications: First or Upper Second Class Honours degree in Biochemistry or a related subject and at least two years relevant post qualifying experience.

Salary: On scale £9687-£13 005. Non-contributory superannuation.

Apply by letter to The Secretary quoting Ref 743 and giving the names of two referees by 22 July. We are an Equal Opportunities Employer.

CHICHESTER HEALTH AUTHORITY

St Richard's Hospital Department of Microbiology

We have two vacancies for JUNIOR LABORATORY SCIENTIFIC OFFICERS

in the Medical Microbiology Department at St Richard's Hospital Chichester.

These posts offer interesting and challenging work in a well-equipped diagnostic medical laboratory where investigations into the diagnosis of disease play a more important part in modern medical care.

Successful candidates will be offered on-the-job training, day release for college, a pleasant working environment and the opportunity to develop a worthwhile career.

Qualifications required: A science degree acceptable to the Council for Professions Supplementary to Medicine or a minimum of two Science 'A' levels, one of which must be Chemistry.

Salary: JMLSO (at 21) £5692-£5867. MISO scale £6686-£9435. Further information from Mr C. Dowling, Department of Microbiology, on Chichester (0243) 788122, Ext 720.

For a job description and an application form please contact the Unit Personnel Office, St Richard's Hospital, Spitalfield Lane, Chichester, West Sussex PO19 4SE. Tel (0243) 788122, Ext 445.

ORGANIC PETROGRAPHER

The Geochem Group has a vacancy for an experienced organic petrographer. The successful applicant must have considerable experience in the examination and identification of sedimentary organic matter in both transmitted and reflected light and be capable of working with a minimum of supervision.

Competitive salary and comprehensive benefits package.

Please apply with cv to Pete Walko, Geochem Laboratories Limited, Chester Street, Salford, Chester CH4 8RD.

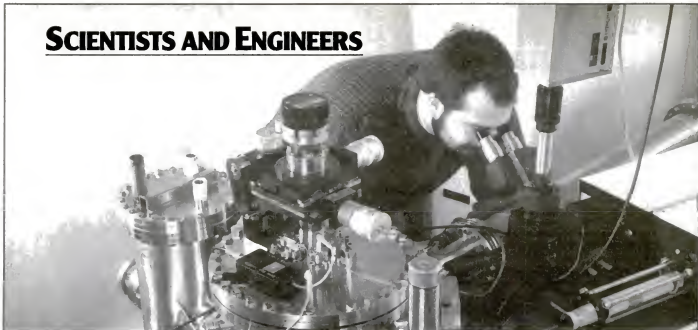
UNIVERSITY OF BRISTOL Department of Pathology and Molecular Genetics Unit WELLCOME TRUST-FUNDED RESEARCH ASSISTANT

required to study the synthesis and expression of ion channels in neurological diseases. Applicants should have a PhD or honours degree in the biological sciences and experience in molecular biology. For further information contact Dr S. Love (0272 701700). Applications, with cv and names of two referees, to: Dr K. D. Perry, Pathology Department, Medical School, Bristol BS8 1TD, by 21 July, 1988.

MONTGOMERY CANAL ECOLOGICAL SURVEY A BOTANIST AND AN ECOLOGIST

are required by the Montgomery Canal Ecological Survey to continue its programme of biological monitoring and reserve creation on the Welsh border. The project is based near Oswestry. It is MSC-funded so applicants should check their eligibility: £22 48/32 hour week. Applications in writing with a cv to Mr T. Martin, CTF, Castle Park, Flint, Clwyd CH6 5XA. Further details from Caroline Tandy on (0691) 831400.

SCIENTISTS AND ENGINEERS



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something
better**

There's nothing like a good idea. And that is often all that we have to start the ball rolling in the development of future technologies. Finding solutions entails the combination of theory and experimentation, putting initial thoughts onto paper, adapting them, putting them into practice and producing results. The next step may be to the drawing board, but it's certainly not a step backwards.

The Atomic Weapons Establishment at Aldermaston in the heart of the Berkshire countryside has an international reputation for its achievements, and is renowned for its pioneering activity in the fields of nuclear science and technology — a name that has been made by the people who work with us.

We have many vacancies in the following disciplines for engineers and scientists:

- o Mechanical Engineers
- o Chemical Engineers
- o Electrical/Electronic Engineers
- o Mathematicians/Physicists
- o Metallurgists
- o Safety Specialists
- o Materials Scientists
- o Computer Scientists

Working in the Atomic Weapons Establishment, you would be part of either the Defence Engineering Service (DES) or the Defence Science Group (DSG) and would be based at one of three sites: Aldermaston or Burghfield in Berkshire, or Foulness on the Essex coast where we have a small number of vacancies.

If you have the technique, we have the technology — so when you come to work at AWE, your career can only start looking up.

Starting salaries are up to £17,000. (Salaries will be reviewed with effect from 1 August 1988). We expect you to have a degree, or HND/HNC and relevant experience. In addition to full-time appointments opportunities also exist for part-time employment and fixed period appointments.

Career prospects are excellent within AWE, and the DES and DSG generally. As well as a comprehensive benefits package, you will be able to enjoy superb leisure facilities, including a theatre/cinema, extensive sports grounds and a subsidised restaurant. Hostel accommodation and housing, or relocation assistance of up to £5000 may be available.

For further details please write to the Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 468551 (answering service operates outside office hours) for an application form, to be returned by 29 July 1988.

For Engineer vacancies please quote ref: T(11)85/34

For Scientist vacancies please quote ref: SY/29/DAWE/34

The Civil Service is an equal opportunity employer

DSG DES



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Salary from £10,000

If you have recently completed a degree in a biological science and have gained at least a second class honours degree you may consider combining your academic ability and innovative approach by joining one of the world's most advanced research centres.

Applicants with some previous research experience would be ideal, such as an ambitious individual seeking an early career move. The person selected will be joining a world class team of neuroscientists within our Biochemistry Department investigating the interaction of drugs with CNS transmitters.

The environment is stimulating and the facilities outstanding. Full employee benefits include private health care and relocation assistance where appropriate.

If you are interested in this exciting opportunity and wish to join the world's leading pharmaceutical company, please send full career details to: Cathy Woodbine, Merck Sharp and Dohme Research Centre, Terlings Park, Eastwick Road, Harlow, Essex CM20 2QR.



MERCK

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Neuroscience Research Centre

HARROW HEALTH AUTHORITY

Northwick Park Hospital &
Clinical Research Centre

Department of Histopathology/
Cytopathology

JUNIOR 'B' MEDICAL
LABORATORY SCIENTIFIC
OFFICER/MEDICAL
LABORATORY SCIENTIFIC
OFFICER

The department provides a wide ranging diagnostic service for the district and will be encouraged to study for higher qualifications. Applicants should hold a minimum qualification of two science A levels or BTEC certificate in Medical Laboratory Science, or a CPBM approved science degree. For the MLSO post state registration is a requirement.

For further information and informal visits to the laboratory contact Mrs G. Sower, Senior Chief MLSO Ext 2053.

For application form and job description contact the Personnel Department, Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3UJ. Tel 01-864 5311, Ext 2001 or 01-423 5370 (24 hours) quoting Ref No S849.

Closing date: 29 July, 1988.

PROCESS DEVELOPMENT OFFICER HOLMES CHAPEL

Fisons Pharmaceuticals is part of a rapidly expanding British company with interests in pharmaceuticals, scientific equipment and horticulture.

The Pharmaceutical Division has its major production site at Holmes Chapel, where the Natural Products Development Department is responsible for development of new ideas and the transfer of new products or alternative manufacturing procedures into production.

This position centres on Clinical Dextran and Iron Dextran processes. Involves working closely with Chemical Production staff to implement new or modified processes, and to help in areas for improving current procedures, and processing. Close involvement with other Divisional departments is also required especially R & D, Q.C. and Engineering. There will be periodic contact with outside suppliers, manufacturers and University establishments.

Candidates should be recent science/technology graduates or HNC/HND qualified with direct experience in colloid or polymer chemistry. Some experience of chemical scale operations and equipment would be an advantage. It is equally important for the candidate to possess the personal qualities necessary to translate concepts and ideas into reality.

In addition to a competitive salary we offer excellent benefits including profit sharing bonus, contributory pension scheme, SAVE Share Scheme, P.P.P. and Sports and Social facilities. Relocation expenses are offered in appropriate cases.

Please apply in writing enclosing a detailed CV and quoting reference number 367 to:

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Cancer Research

£10 100-£13 300

The ICRF is the largest privately funded cancer research organisation in Europe. Its Biomedical Computing Unit is internationally known for its work on Artificial Intelligence and biomedicine, with a unique applications programme in medicine and molecular biology, and supporting research in fundamental A1 and computer science. The Unit requires a programmer to provide technical support. The Unit has a network of 13 Sun workstations, several PC's and links with the ICRF cluster of two VAX 8700s.

The technical support role is a challenging one within a group working on a range of innovative and demanding projects. Applicants should have a good computer science degree and/or professional computing experience. Unix experience is essential.

Further details can be obtained from Dr John Fox.

Applications should be made by sending full cv and names and addresses of three referees to Mrs P Harwood, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2A 3PX no later than 22 July, 1988 quoting ref 225/R

Smoking is actively discouraged.

**I M P E R I A L
CANCER RESEARCH FUND**

CHEMISTS FOR NEW PRODUCT DEVELOPMENT & CUSTOMER TECHNICAL SERVICE

Additives for Lubricants & Fuels

INDUSTRIAL GROUP

Research & Development Projects: developing and testing new additive systems for automotive, hydraulic and industrial lubricants. While relevant experience would be ideal, we would also be pleased to hear from chemists with strong interpersonal and technical abilities.

Customer Technical Service: working on laboratory development and testing of formulations and preparation of technical reports and presentations to meet the needs of short-term customer-oriented development programmes. Experience of providing direct sales support in the area of gear/industrial lubricant additives (or the potential to do so) is desirable.

FUELS GROUP

Technical Service Executive: providing complete technical support for customers of fuel additives in Europe and Middle East including organising, prioritising and supervising direct support for sales team; planning and implementing customer development programmes and presentations. 3-5 years' experience of fuels/additives gained in the petroleum/refining industry would be ideal. Sound knowledge of fuel specifications and tests is essential.

Ethyl Petroleum Additives Limited, part of the Ethyl Corporation, is a major independent supplier of lubricant and fuel additives to the oil industry. Our European Technical Centre located in Bracknell is responsible for the development of new fuel and lubricant additive formulations to meet market needs in Europe, Middle East and Africa.



Fuels Development: developing and formulating new additives for fuels for Europe, Africa and the Middle East including monitoring research projects; defining and implementing solutions; organising tests; writing reports. At least 2 years' post-graduate experience ideal. PhD in Organic Chemistry, fuel additive research experience and computer knowledge would be an advantage.

All candidates will ideally have BSc (Hons) Chemistry, be flexible self-starters with good communication skills and able to handle several projects at once.

We offer very competitive salaries, non-contributory pension, private health plan, life assurance, together with other benefits expected of an international company.

Please telephone for more information or send cv, indicating current salary, to Pat New, Personnel & Administration Manager, Ethyl Petroleum Additives Ltd, London Road, Bracknell, Berkshire RG12 2UW. Tel: 0344 420511.

Ethyl Petroleum Additives Ltd

HARINGEY HEALTH AUTHORITY

North Middlesex Hospital
MLSO/JUNIOR 'B'—
MICROBIOLOGY

There is a vacancy in the Microbiology Laboratory of this busy District General Hospital for a basic grade MLSO holding an appropriate qualification.

An appropriate science degree or 'A' levels will be considered for the Junior 'B' MLSO post.

This six year old, well equipped laboratory offers interesting and varied work, encouragement will be given to study for the special examination of the IMLS. For graduates and 'A' level school leavers, support will be given to study for the HNC/BTEC Pathology Laboratory qualification.

An on-call rota is in operation for suitably qualified staff.

Salary: MLSO £7404-£10 153 pa inclusive (Pay Award Pending). Junior B £5290 (Age 18) £6585 pa inclusive (Pay Award Pending).

Informal inquiries are welcome, please phone Alan Baldwin on 01-807 3071, Ext 3672.

Application forms and job descriptions from the Personnel Department, North Middlesex Hospital, Sterling Way, Edmondson N18 1QX, or Tel 01-807 2835 (24 hour answering service) quoting the above reference number.

Closing date: 7 July, 1988.

HHA is working towards Equal Opportunities and welcomes applications from all sections of the community.

BROMLEY HEALTH AUTHORITY

DGH (South) Farnborough Hospital

The Biochemistry Department in the Pathology Laboratory at Farnborough Hospital has the following vacancies

TRAINEE LABORATORY STAFF

We are looking for a graduate or school leaver with either an appropriate Science Degree or 'A' levels in chemistry and one other subject to train as a Medical Laboratory Officer, specialising in Biochemistry. We will give you the appropriate training and educational support, if necessary, to become a fully qualified Medical Laboratory Scientific Officer and embark on a rewarding career in this vital part of our health care team.

Starting salary will be in the range £4627 pa (at age 17) to £5855 pa according to age (under review).

MEDICAL LABORATORY SCIENTIFIC OFFICER

Applications are invited from suitably qualified MLSOs or those studying for the BTEC HNC in MLS (Biochemistry).

Salary is in the range £7404-£10 153 pa (under review).

For further details and application forms for both of the above posts, please contact the Unit Personnel Department on Tel 0689 62761 (24-hour answering phone).

Closing date: 11 August, 1988.

BARNET HEALTH AUTHORITY

General Hospitals Unit

Department of Microbiology

MEDICAL LABORATORY SCIENTIFIC OFFICER—
BASIC OR JUNIOR B GRADE

We have vacancies for the above at Edgware General Hospital.

A wide based training will be given including day release and the successful candidate will be encouraged to proceed to the Special Examination for Fellowship of the IMLS.

Candidates applying for the basic grade post should have suitable qualifications, be experienced in basic microbiological techniques and preferably be state registered. Those applying for the Junior B post should hold a BTEC/HNC in Medical Laboratory Sciences or an appropriate Science degree or have two Science A levels including Chemistry.

Salary: Basic Grade: £7404-£10 153 pa. Junior B: £4927-£6585 pa (dependent on age). (Both inclusive of London Weighting).

Temporary single accommodation may be available.

For an informal discussion/visit please contact Miss Julie Welch, Senior Chief MLSO on Tel 01-440 5111, Ext 4394.

Job description and application form from the Personnel Department, Edgware General Hospital, Edgware, Middlesex. Tel 01-952 2381, Ext 6208.

Closing date: 14 July, 1988.

UNIVERSITY COLLEGE HOSPITAL

RADIATION PROTECTION TECHNICIAN (MPT IV)

Salary: £7493-£9472 pa inclusive.

A Medical Physics Technician is required to join the team providing a comprehensive radiation protection service to Bloomsbury Health Authority. Based in the Medical Physics Department, the person appointed may become involved in any aspect of radiation protection, but will be particularly concerned with the routine running of the District film badge service, extremity monitoring service, and radiation surveys.

Applicants should have two passes at GCE A level (or equivalent) and relevant scientific experience. Applicants with lesser qualifications may be considered at a lower grade.

Opportunities exist to study for higher qualifications.

For further information contact Mr P. J. Mulvey in the Department of Medical Physics—Tel 01-380 9700.

For an application form and job description contact, the Personnel Department, University College Hospital, Gower Street, London WC1E 6AU or Tel 01-380 9699 (24 hour answering service) quoting Ref No IF 15.

Closing date: 13 July, 1988.

Bloomsbury Health Authority working towards Equal Opportunities.

UNIVERSITY OF NEWCASTLE UPON TYNE

SUBSTRATE TRANSPORT IN FUNGI

Applications are invited for a RESEARCH ASSOCIATESHIP at POST-DOCTORAL level in an AFRC-supported study to investigate the transport mechanisms involved in the uptake of lignin-related aromatic compounds by fungi. This is a continuation of a previous three-year project and would probably centre on the likely involvement of a membrane-bound ATPase or of binding proteins in the uptake system. Appointment is for one year in the first instance and would be particularly suitable for microbiology- or biochemistry-trained applicants with previous postgraduate experience in some aspect of substrate transport studies. Candidates needing additional time to complete their thesis preparation will be considered.

Salary will be at an appropriate point on the Grade 1A scale: £9865-£15 720 pa according to qualifications and experience.

RESEARCH IN ENVIRONMENTAL MICROBIOLOGY

Applications are invited for the following SERC-CASE postgraduate studentships:

1. To investigate the biodegradation of synthetic lubricants and related products in the aquatic environment by eukaryotic micro-algae, in collaboration with Castrol Limited.
2. To investigate the biodegradation and metabolism of sucralose, a new synthetic sweetener, by soil and water microorganisms, in collaboration with Tate and Lyle Limited.

The studentship stipend for these awards will be significantly supplemented by the respective collaborating companies. Applicants should have, or expect to obtain shortly, a first or upper second-class Honours degree in Microbiology, Botany, Biochemistry or other appropriate biological science.

Applicants for the above post or studentships should submit, as soon as possible, a cv and the names of two referees to Professor R. B. Cain, Department of Agricultural and Environmental Science, The University, Newcastle upon Tyne NE1 7RU. Tel 091 232 8511, Ext 2890, from whom further details are available.

CENTRAL MIDDLESEX HOSPITAL
Department of Gastroenterology & NutritionRESEARCH
TECHNICIAN

Applications are invited for the post of Research Technician in the team directed by Dr David Silk. We are investigating intestinal absorption of dietary constituents (proteins, peptides, amino acids, fats and carbohydrates) and intravenous utilisation of novel substrates. A wide range of analytical techniques are applied in this work (HPLC, GC/MS, automated chemistry) and the applicant should be conversant with the principles of modern techniques.

The successful candidate will possess an HND or degree in a Biological Science or Chemistry and will be appointed at the appropriate point on the MLSO scale, depending on age and experience.

The appointment will be for one year in the first instance (extendable to two years) and further details are available on request.

A letter of application and cv should be sent to Dr G. K. Gimble, Department of Gastroenterology and Nutrition, Central Middlesex Hospital, Acton Lane, London NW10 7NS (01-865-6733 Ext 2208). The envelope should be marked 'Research Technician'.

Closing date: three weeks from date of advertisement.

THE UNIVERSITY OF DUNDEE
Department of Biochemical MedicineRESEARCH ASSISTANTSHIP
IN
MOLECULAR MEDICINE

Applications are invited from recent graduates or postgraduates for this vacancy in the laboratory of Professor B. Burchell. Appointment may be made at either research assistant or postdoctoral level.

The successful candidate will be involved in studies of the regulation of expression of UDP-glucuronyltransferase cDNAs and epoxide hydrolases, and their introduction into genetically deficient cells as a model drug metabolizing system. The position is available from 1 October, 1988.

Informal enquiries can be made to Professor Burchell (0382-23181 ext. 4235).

Applications, with CV (2 copies) and the names and addresses of two referees to the Personnel Office, The University, Dundee, DD1 4HN. Please quote reference EST/424/88/NS. Closing date 14/7/88.

HATFIELD POLYTECHNIC

Temporary
Lectureship in Biochemistry

(September 1988-August 1989)

Salary: £10 380-£15 678

Applications are invited from postdoctorates with expertise in any area of metabolic biochemistry for this one year appointment. The successful applicant will be required to teach general biochemistry to MSc, BSc and HNC students in Applied Biology. Informal enquiries may be made to Dr I. Simpkins (07072 79552).

Application forms and further details may be obtained from the Personnel Office, Hatfield Polytechnic, College Lane, Hatfield, Herts AL10 9AB, or Tel Hatfield (07072) 79802.

Closing date for completed applications 5 August 1988.

THE MEDICAL COLLEGE OF SAINT BARTHOLOMEW'S HOSPITAL
(University of London)Technician
Biochemistry Department

Technician (graduate or equivalent qualifications) required to work as part of research team involved in the study of the molecular basis of brain and muscle function and to contribute to general departmental duties as required.

Salary—£7887-£10 636 pa (incl £1201 London Weighting).

Applications in the form of a full cv with the names of two referees to Professor J. B. Clark, Department of Biochemistry, Medical College of St Bartholomew's Hospital, Charterhouse Square, London, EC1M 6BQ, from whom further details may be obtained—Tel: 01-253 0661 Ext 22.

Closing date: 14 July, 1988.

UNIVERSITY OF EDINBURGH
Department of Zoology

A vacancy exists for a

RESEARCH ASSOCIATE

starting late this summer, to work on the behaviour of mice as part of a programme funded by the Health and Safety Executive on the neural, chemical and behavioural effects of anti-convulsant drugs. A variety of behavioural tests are being used.

Some experience of behavioural work and simple computing would be an advantage.

Candidates should hold a degree in a related subject.

Salary on Range 1B scale £8875-£11 680 with placement according to age and qualifications.

The position is grant supported until 31 March, 1991.

Applications, which should include cv and names and addresses of two referees, should be sent to Prof A. Manning, Department of Zoology, West Main Road, Edinburgh EH9 3JT. Tel 031-667 1081, Ext 3208 or 18 July, 1988. Please quote Ref 5558.

UNIVERSITY OF KEELE

Department of Physics
POSTDOCTORAL RESEARCH
ASSISTANT

Applications are invited for a postdoctoral research assistantship to work with Prof M. J. Gillan on the ab initio calculation of the properties of solids. Applicants should have, or expect to receive, a PhD in an appropriate area. The calculation of solid-state structure and energetics using electronic-structure methods is an exciting and rapidly-developing field. The work will focus on the ab initio study of defects in metals and insulators using novel techniques recently proposed by Car and Parrinello and is expected to lead to major advances.

The position is funded by the SERC and is tenable for up to three years with a salary on the RA1(A) scale. Application forms and further details can be obtained from The Registrar, University of Keele, Keele, Staffs ST5 5BG. (Tel 0782-621111, Ext 3005). Informal enquiries to Prof M. Gillan (Tel 0782-621111, Ext 3911) are welcomed. Closing date 29 July, 1988.

CLINICAL RESEARCH MANAGER

London based: Major Japanese Company
£24-30,000 + car

A greenfield opportunity to influence the development of clinical research for one of the world's most innovative and productive pharmaceutical houses, accelerating into the next phase of its long-term strategy – away from licensing and joint venture operations towards the creation of a major international business in its own right.

A life science (post) graduate, probably 30-40, with broad-based and progressive clinical research experience to Team/Project Leader level, working routinely to GCP standards, you will be the founder member of the company's new European team, with unrivalled opportunities to:

- build the most effective clinical research group in the UK/European industry
- lead the development of an impressive portfolio of NCE's (current focus is cardiovascular) – initially in Phases II/III, but across all phases in the medium term
- maintain and expand your personal contacts with clinical opinion leaders and researchers inside and outside the company, and operate at the leading edge.

Please write now with succinct, comprehensive CV and list of publications, or telephone Roger Stephens, who is advising on this key appointment. Ref. 8848.

Roger Stephens
& Associates

3 Park Street, Old Hatfield, Herts AL9 5AT
Telephone: 07072 75361 Fax 07072 71366



Central Toxicology Laboratory

OPPORTUNITIES IN METABOLISM AND PHARMACOKINETICS

The Central Toxicology Laboratory is responsible for the provision of a comprehensive toxicological service to the ICI Group worldwide.

As a result of recent reorganisation a position is now available for a Biochemist to work within the Comparative Toxicology Group within the laboratory. You should be a Biochemistry/Biology based Graduate or an HNC/HND with practical laboratory experience incorporating a variety of Biochemical techniques. Depending on the level of entry, a different extent of experience would be required. Unfortunately, this position is not suitable for PhD Scientists.

The group is involved in the study of Metabolism and Pharmacokinetics to elucidate the mechanism of action of chemicals in different species including man. This involves the identification of metabolites, the enzymes involved in their formation, the reasons for target cell selectivity and structure activity

relationships for a range of similar chemicals.

Starting salary will be between £9,000 to £11,500 depending on experience. Progression is based on individual merit and benefits include a profit sharing scheme, contributory occupational pension and an active sports and social club. The laboratory is located in beautiful parkland in rural Cheshire yet only 15 miles south of Manchester. Assistance is available for relocation to this area where there are excellent housing and educational facilities.

To apply please write enclosing a comprehensive up to date CV, quoting reference B/BT/ME and include the names of two referees to: **The Personnel Section, ICI Central Toxicology Laboratory, Alderley Park, Macclesfield, Cheshire, SK10 4TJ. All replies must be returned by 18 July 1988.**

It is our practice not to acknowledge CV's but we will let you know the final outcome of your application.

"World Class"

ICI is an equal opportunities employer.



Scientists and Engineers

Gypsum and Board Products Development

The international Redland Group provides quality building materials and services to the construction industry throughout the world with sales of £1.8 billion over the last financial year. The Group has an active research and development policy which has resulted in the commercialisation of novel building products.

Redland Technology is the Group's central resource for new product and technology development. Its laboratories are well equipped with modern facilities up to pilot plant scale and are located in attractive countryside south of London.

We now require a qualified chemist or materials scientist and a development engineer to expand

our efforts in developing building board and gypsum based products. For the materials post, candidates should ideally hold a PhD in an appropriate discipline or a first degree with relevant industrial experience. It is anticipated that the development engineer may hold similar qualifications but with the emphasis towards industrial experience.

You will be rewarded with an excellent salary and benefits package including relocation and mortgage assistance where appropriate. Telephone for an application form, or send your C.V. to Dr G M Hartley, Personnel Manager, Redland Technology Limited, Graylands, Horsham, West Sussex, RH12 4QG. (Telephone 0403 50222) quoting reference 12/88.

Redland Technology

Researching tomorrow's materials

REDTECH

UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF PURE AND APPLIED CHEMISTRY

RESEARCH ASSISTANTSHIP

Applications are invited for a Postgraduate Research Assistantship, initially tenable for two years, to work on a project in collaboration with Exxon Chemicals, to study long chain hydrocarbons relevant to wax crystallisation which will involve modelling habit modification and work on the SERC's Synchrotron Radiation Source at Daresbury Laboratory. Applicants should possess a good honours degree preferably with experience in molecular modelling or crystallography. Candidates will be encouraged to register for a higher degree.

Salary on Scale £8675-£11 680 pa.

Applications (Quote Ref: R29/88) with full cv and the names and addresses of three referees should be sent to Dr K. Roberts, Department of Pure and Applied Chemistry, University of Strathclyde, Thomas Graham Building, 295 Cathedral Street, Glasgow G1 1XL by 25 July, 1988.

SCIENTIST/ENGINEER

The British Board of Agrément, a Government sponsored organisation assessing and certifying products for the construction industry, has a vacancy for a SCIENTIST or ENGINEER in the building physics section based at Gerrard, Watford.

This is a career opportunity to join a small group concerned with assessing the performance of products in use by applying physical principles to technical problems in the whole range of building physics.

The work involves all stages of the contractual process from drafting an initial contract to carrying out the technical assessment, liaising with our customers and finally writing certificates and reports.

Applicants should possess a considerable degree of initiative, self-reliance and acceptance of responsibility in seeing a project through to completion, as well as a broad-based knowledge of physics and the ability to apply that knowledge. A high standard of numeracy is required.

Candidates should possess an honours degree or equivalent in a science or engineering discipline and have a keen interest in extending their knowledge and experience into the various specialist areas of building physics. Experience in these topics would be an advantage but candidates without relevant experience may apply.

Salary: £9132-£12 110 pa (inclusive of Outer London Weighting Allowance), depending on age and experience. Non-contributory pension and life assurance scheme.

Application forms from: Mrs L. M. Brinklow, British Board of Agrément, PO Box 199, Bucknalls Lane, Gerrard, Watford, Herts WD23 7NG. Tel: 0923 670844.



NORTH EAST LONDON POLYTECHNIC

Department of Medical Sciences & Health Studies

Microbial Technology Research Group

RESEARCH ASSISTANT

This expanding research group has a vacancy suitable for a microbiologist or biochemist. The three year post is funded by the Cancer Research Campaign. The project is to investigate the production of carcinogens by the gut flora and will include fermentation technology and transposon mutagenesis. Experience with fastidious micro-organisms, mutagenesis or fermentation technology would be an advantage. The successful candidate would be expected to register for a higher degree. The post is immediately available.

Salary scale: £8106-£9165 including London Weighting.

Applications with cv should be addressed to Dr S. Forsythe, Department of Medical Sciences & Health Studies, NELP, Romford Road, London E15 4LZ. Tel 01-590 7722, Ext 4130. Closing date two weeks from publication.

MEDICAL RESEARCH COUNCIL

Radiobiology Unit, Oxon
RESEARCH OFFICER
in the Cell and Molecular Biology Division.

To work on the fundamental mechanisms of cytogenetic changes induced by ionising radiation and other DNA damaging agents. Projects will involve the use of a variety of modern cytogenetic identification techniques applied to human cells in tissue culture. Some experience in tissue culture and cytogenetics would be an advantage, but training will be given. Duties will also include an element of laboratory management.

Qualifications required are a degree/HNC in a relevant subject. This is a permanent post. Salary on an incremental scale rising to £9895 pa (under review). Initial placement depending on experience.

We are situated on the Harwell Laboratory Site and offer excellent working conditions in pleasant rural surroundings convenient for Oxford. Hostel accommodation available for non-local applicants.

Informal enquiries would be welcomed by Dr Thacker or Dr Savage on (0235) 834393. Please write or telephone for an application form to the Personnel Officer, MRC Radiobiology Unit, Chilton, Didcot, Oxon OX11 0RD. Tel (0235) 833882 for our 24 hour answer phone. Closing date: 22 July, 1988.

The Council is an Equal Opportunity Employer.

UNIVERSITY OF CAMBRIDGE

Department of Zoology
RESEARCH ASSISTANT—
VERTEBRATE ECOLOGY

A three-year post is available for an assistant to join a small group working on the ecology of red deer and sheep.

The job will involve computer analysis of existing data sets as well as field work in the Hebrides. Applicants should have relevant qualifications in a biological science and/or computing to be under the age of 26. Salary up to £11 680 depending on age and experience.

Applications with cv and names of two referees to Dr T. H. Clutton-Brock, Department of Zoology, 34a Storey's Way, Cambridge CB3 0DT.

THE UNIVERSITY OF MANCHESTER

Department of Renal Medicine and Immunology
RESEARCH TECHNICIAN

required for a two year post supported by the National Kidney Research Fund, to extend a project investigating autoimmunity in IgA nephropathy. Candidates should have HNC or equivalent and experience in immunology is essential. Expertise in chromatography, ELISA or cell culture is desirable.

Salary scale: £8088-£8343 pa.

Enquiries and cv to Dr P. W. Ballardie (061-276 4148), Department of Renal Medicine, Manchester Royal Infirmary, Oxford Road, Manchester M13 9WL.

SHELL RESEARCH LIMITED SITTINGBOURNE, KENT

Micropropagation Technician-Forestry

Shell Research Limited has a vacancy at its Sittingbourne Research Centre in Kent for a Technician to join a research team in the Plant Cell & Molecular Biology Group of the Physiology & Biological Chemistry Division.

This research team develops methods for the vegetative propagation of forest trees in support of Shell's established and expanding worldwide forestry business.

The successful candidate will be involved with micropropagation research. He/she will be responsible for the preparation of equipment and plant material for experiments, the monitoring of experiments, and the recording and analysis of results. Progressive involvement in experimental design, and in the communication of results, would be anticipated.

We would like to hear from applicants who have formal training to at least HNC level or equivalent. Plant tissue culture experience is essential.

We offer competitive salaries, free lunches and excellent sports and social facilities.

If you are interested in this vacancy, please write for an application form quoting reference No: 880017 to: Mrs M A Newton, Personnel Division, Shell Research Limited, Sittingbourne Research Centre, Sittingbourne, Kent.

Closing date for receipt of applications 14th July 1988.



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Got a science degree or lab experience? Looking for a more exciting way of capitalising on your scientific training? You could take the first step into a highly successful career in sales and marketing

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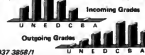
ASHBOURNE

MATHEMATICS AND SCIENCE TUTORS

Small group tuition in an informal but disciplined environment in a college converted to a private residence. Applications are invited now for full time and part time posts beginning September 1988. Ashbourne & D.E.S. sponsored. Reply with CV to the Secretary,

Ashbourne Tutors,
59/61 Kensington High St.
London W8 5EQ. Tel: 01-937 3858/1

Results 1982/1987



PROFESSIONALS WITH AN EYE FOR THE FUTURE

WasteChem is a rapidly expanding company serving the growing need for treatment of radioactive waste and the decommissioning of nuclear facilities. It is jointly owned by Balfour Beatty, the major UK construction group, and NUKEM GmbH, the leading West German company in radioactive waste treatment.

We are now entering our next phase of planned expansion and are looking for highly motivated and enthusiastic people to develop with the Company.

Health Physicist (WCP/HP)

The ideal candidate will be qualified to minimum HND/HNC level, supplemented by membership of the Society of Radiological Protection. The importance of this post demands at least 8 years' relevant experience, which should have incorporated project work relating to all types of radiation. Experience in decommissioning would be an advantage as the work will involve supervision

of the health physics aspects of our decommissioning sites.

Assistant Health Physicist (WCP/AHP)

This position provides excellent scope for career development for a Science Graduate with at least 5 years' relevant experience, who wants to gain site experience of decommissioning work.

For the above posts we offer an attractive salary and benefits package. These positions are also characterised by the first-class opportunity to join a young, progressive company where ambition and commitment will be well rewarded.

To apply, send full CV's and details to Alan Brant, Operations Manager, or contact Jenny Shaw for application forms at WasteChem Limited, Bramhall Centre, Bramhall, Cheshire SK7 2BY, telephone 061-439 8034, quoting appropriate reference number.

WasteChem



STATISTICIAN/ PHARMACOLOGIST

Data Analysis & Research (DAR) is a rapidly growing company offering a comprehensive clinical research service to the pharmaceutical industry. DAR Ltd operates from offices in New Lanark in Scotland and from the Innovation Centre on Cambridge Science Park.

The company intends to further expand the Department based in New Lanark which is concerned with the production of clinical study reports by recruiting either a Statistician or a Pharmacologist. The successful applicant will be involved in the analysis and introduction of clinical trial data and the production of a final report. Applicants should have at least a good Honours degree. Special consideration will be given to those with a Higher degree, and particularly to those with relevant experience from within the pharmaceutical industry. Applications should be sent in writing to:

Dr M. I. Foreman, Data Analysis & Research Ltd, The Bell Tower, New Lanark ML11 9DH, Lanarkshire.

UNIVERSITY OF LIVERPOOL

Department of Genetics RESEARCH ASSISTANT/ SENIOR RESEARCH ASSISTANT

Applications are invited for the post of Research Assistant/Senior Research Assistant in the Department of Genetics. The project is concerned with the molecular characterisation of the trans-acting regulatory gene responsible for nitrogen metabolite repression in *Aspergillus nidulans*. Experience in molecular genetic techniques is desirable. A postdoctoral appointment would be preferred but graduates will be considered and may be eligible to register for PhD. Informal enquiries may be made to Dr M. X. Caddick, Tel 051-709 6022, Ext 3116.

The project is financed for three years by the SERC at an initial salary within the range £8675-£10 460 pa.

Applications, together with the names of three referees, should be received not later than 15 July, 1988, by The Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained.

Quote Ref RV/976/NS.

An Equal Opportunity Employer.

QUEEN MARY COLLEGE

(University of London)

RESEARCH POSITIONS IN ASTRONOMY

Applications are invited for two post-doctoral positions in Prof M. Rowan-Robinson's IRAS group, currently working on cosmology, starburst and active galaxies, background radiation and star formation. The posts are for (a) a post-doctoral programmer, to start as soon as possible, (b) an observational astronomer, to start 1 October, 1988. Salaries will be in the range of £11 910-£14 815 including London Allowance, and the appointments will be for two years in the first instance with a possible year's renewal.

Applications should include a brief cv, publication list, summary of research and/or programming experience and the names of two referees who have been asked to forward letters of reference directly to Professor Rowan-Robinson. Applications and letters of reference should arrive no later than 22 July, 1988. Send applications (two copies) to Professor Rowan-Robinson, School of Mathematical Sciences, Queen Mary College, Mile End Road, London E1 4NS. Quote Ref No 88/68.

THE UNIVERSITY OF
NEW SOUTH WALES
Sydney, Australia

PROFESSOR OF ELECTRICAL ENGINEERING

in the field of Communications

Applications are invited for appointment to a Chair of Electrical Engineering in the field of Communications. The Chair, in the School of Electrical Engineering and Computer Science, has become vacant on the retirement of Professor A. E. Karbowiak, the foundation professor in this field, and is available from January 1989.

The School comprises five departments: Communications, Computer Science, Electric Power Engineering, Electronics, and Systems and Control. The School also houses the Joint Microelectronics Research Centre. The Department of Communications has an academic staff of 14 who are supported by professional and technical personnel. Present research work within the Department places particular emphasis on optical and digital communications, UHF micro-waves and antennas, signal processing and acoustics, solid-state devices, and human factors and communications aids.

The appointee will have a distinguished record of research and will be responsible for the direction of the Department in its teaching and research activities and for maintaining and strengthening links with industry and government bodies in the area of telecommunications. The University intends that the appointee will be Head of the Department of Communications for an initial period which may be subject to renewal. The appointee will also be expected to serve as Head of School for a term, or terms, if so requested.

Enquiries regarding the Chair may be addressed to Professor N. L. Svensson, Dean of the Faculty of Engineering, or to Professor N. W. Rees, Head of the School of Electrical Engineering and Computer Science, University of New South Wales, from whom further information may be obtained regarding areas of research interest in the Department and the School.

Salary: A\$59 183 pa.

Subject to consent by the University, professors may undertake a limited amount of higher consultancy work. The University reserves the right to fill any Chair by invitation.

Details of the position together with conditions of appointment and application procedure are available from the Senior Appointments Unit, University of New South Wales, PO Box 1, Kensington, NSW, 2033, Australia.

Applications close: 23 September, 1988.

Equality of employment opportunity is University policy.



NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF PHARMACY

Applications are invited for teaching appointments in the Department of Pharmacy from candidates who should possess a basic degree in pharmacy and a PhD degree in a pharmacy speciality.

Gross annual emoluments range as follows:

Lecturer	SS43 850-SS57 350
Senior Lecturer	SS51 950-SS91 070
Associate Professor	SS79 780-SS109 880
(STGE1-00=SS3-66 approximately)	

The commencing salary will depend on the candidate's qualifications, experience and the level of appointment offered.

Leave and medical benefits will be provided. Depending on the type of contract offered, other benefits may include: provident fund benefits or an end-of-contract gratuity, a settling-in allowance of \$51000 or \$52000, subsidised housing at nominal rentals ranging from \$5100 to \$5216 p.m., education allowance for up to three children subject to a maximum of \$510000 per annum per child, passage assistance and baggage allowance for the transportation of personal effects to Singapore. Staff members may undertake consultation work, subject to the approval of the University, and retain consultation fees up to a maximum of 60% of their gross annual emoluments in a calendar year.

The Department of Pharmacy is a department in the Faculty of Science. There are eight faculties in the National University of Singapore with a current student enrolment of some 14000. All departments are well-equipped with a wide range of facilities to enhance the teaching and research activities of staff members. The University is linked to BITNET, an international network that interconnects almost 500 mainframe computers at 200 institutions of higher learning and research centres around the world.

Application forms and further information on terms and conditions of service may be obtained from:

The Director
Personnel Department
National University of Singapore
10 Kent Ridge Crescent
Singapore 0511

NUS Overseas Office
Singapore High Commission in London
5 Chesham Street
London SW1
U.K.
Tel: (01) 235-4562

Enquiries may also be sent through BITNET to: PERSDEPT @ NUSVM

NEWTECH LIMITED

TECHNICIAN: FOOD MICROBIOLOGY/ FOOD ANALYSIS

We need a technician to work on food microbiology/food analysis. The person should be a graduate or HND level, and must be capable of working without supervision; previous experience would be valuable. The salary in the range of £7000-£9000 pa depending upon experience.

Apply with personal details to Dr D. V. Heelis, Senior Microbiologist, to:

Newtech Innovation Centre,
Newtech Square, First Avenue,
Deeside Industrial Park, Deeside,
Clywd CH5 2NU.

Closing date: Friday 8 July, 1988.

INSTITUTE OF ZOOLOGY ZOOLOGICAL SOCIETY OF LONDON

LABORATORY TECHNICIAN

experienced in bacteriology, required for research on infectious diseases of animals. Candidates must possess a BSc or equivalent qualifications. The appointment, available from mid-August, will be for one year initially. Salary within range £8382-£9783, inclusive of London weighting, according to age and qualifications.

Please apply in writing by providing cv and names and addresses of two referees to the Establishment Officer, London Zoo, Regent's Park, London NW1 4RY (quoting reference GRS/NCLCM) by 4 July, 1988.

UNIVERSITY OF SURREY Department of Chemical and Process Engineering

POSTGRADUATE AND POSTDOCTORAL RESEARCH OPPORTUNITIES

Openings are available for two Postdoctoral and one Postgraduate Research posts and two Research Students to join the established and expanding Particle Technology Group. Applications are invited from innovative thinkers with qualifications in Engineering (Chemical or Mechanical) or Science (Physics or Materials Science).

Three researchers are sought, to undertake two major research programmes, funded by the SERC.

1. Cake Formation and Fracture in Cohesive Solids (Supervised by Dr J. P. K. Seville and Prof R Clift)

This project is intended to develop a quantitative understanding of the cohesive and adhesive strength of cakes of fine particles with gas as the interstitial fluid, to develop experimental methods to evaluate the theory, and to apply the results to gas filters and other industrial processes. A Postdoctoral Fellow is required to develop the theory and design test procedures, while Postgraduate Research Officer will be expected to design and use equipment to implement the test procedures. The Postdoctoral Fellow will also be expected to supervise industrial projects, some of which have already started, in which the scientific understanding is applied directly.

2. Impact Commmination of Particulate Solids (Supervised by Dr M. Ghadiri)

This project aims to investigate the fundamental mechanisms of comminution by impact, in particular, fracture transition from brittle/semi-brittle to ductile failure under high strain rates, characterisation of comminution products from an analysis of crack morphology and paths, and the effect of combined shear and normal loading. A Postdoctoral Research Fellow is required to carry out this programme.

Appointments will be for three years, with salaries on the Research and Analogous 1A and 1B scales (Postdoctoral: £9865 to £15 720; Postgraduate: £8675 to £11 680), at a point commensurate with age and experience.

Two SERC CASE Studentships are also available, both sponsored by Unilever Research, Port Sunlight Laboratories. The successful applicants will be based at the University with some time at the Unilever laboratories, and will follow a PhD research programme on one of the following projects:

1. Impact attrition of Spray-Dried Powders (Supervised by Dr M. Ghadiri)

The influence of internal structure, through the constituent effects of particle size and shape and interparticle bonding will be investigated.

2. Growth and Breakdown in Wet Granulation (Supervised by Dr J. P. K. Seville)

This project is aimed at investigating how the strength and deformation properties of wet particulate materials determine their granulation behaviour.

Further information may be obtained from Prof R. Clift (Tel 0483-509239). Applications for the research posts in the form of a cv (three copies) including the names and addresses of two referees should be sent to the Personnel Office (JLG), University of Surrey, Guildford GU2 5XH quoting Ref 720. Applications for the Studentships should be sent direct to Prof R. Clift. Closing date 15 July, 1988.

NATIONAL COLLECTIONS OF INDUSTRIAL & MARINE BACTERIA LTD

MICROBIAL GENETICIST

NCIMB Ltd is a busy microbiological service company incorporating one of the world's major national culture collections. A vacancy has arisen for a microbial geneticist to take over the management of our expanding collection of bacterial host/vector systems, recombinants and mutants and to work on the development and application of molecular techniques to the identification of industrially important bacteria.

Qualification: Good honours degree in microbiology or related subject. Postgraduate experience of the use of molecular biological techniques in microbiology would be an advantage.

Salary: £9000-£13 500 depending on qualifications and experience.

Written applications plus cv and names of two referees by 15 July to NCIMB Ltd, PO Box 31, Aberdeen AB9 8DG.

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We have a vacancy for a additional Clinical Research Associate to be involved in the design, monitoring and analysis of our clinical trials programme.

The person we are looking for must have:—

- A degree in a scientific discipline such as pharmacology or biological sciences
- Two years' experience of conducting clinical trials
- The ability to communicate effectively at all levels in a medical environment.

We offer an attractive salary, company car, and other first-class benefits. You will be working in a stimulating atmosphere in a relatively small department which values a high degree of individual initiative and commitment.

Please write to Mrs J C Mackinson, Senior Personnel Officer, enclosing full career and personal details or telephone the Personnel Department on (024 024) 3541 for an application form.



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THE UNIVERSITY OF SHEFFIELD
School of Materials and
Department of Chemistry

SERC MOLECULAR ELECTRONICS INITIATIVE

Research into the preparation and electroactive properties of liquid crystal films prepared by complexation of ionic mesogens with polymers. The research programme will be directed by Dr D. Bruce, Dr D. Durrant and Professor P. M. Mathias (Department of Chemistry) and Dr P. V. Wright (School of Materials).

Applications are invited from suitably qualified chemists, physicists or materials scientists for 2 Postdoctoral Associateships (for up to 2 years) 2 SERC supported Studentships (for up to 3 years, intended to lead to the degree of PhD) Salaries for the postdoctoral positions will be within the first four points of the scale for Research & Analogous Staff, grade 1A (£9865-£11 680 pa), according to age, qualifications and experience.

Applications including full cv and the names and addresses of two referees should be sent to Dr P. V. Wright, School of Materials, The University, Emerald, Netherland Road, Sheffield S10 2TZ, to arrive by 22 July 1988. Please quote Ref MAP040/JH.

An Equal Opportunity Employer

FORESTRY COMMISSION RESEARCH STATION

Alice Holt Lodge, Wrecclesham, Farnham, Surrey

Applications are invited for the post of

PROJECT LEADER

The appointee will work to the Head of Wildlife and Conservation Research Branch and will be responsible for planning, implementing, analysing and writing research into damage to trees and other forest vegetation caused by vertebrates. The post also involves liaison between other research workers within and outside the Forestry Commission.

Qualifications — Applicants should possess a degree or equivalent in a biological subject and should have post graduate experience of management/research of herbivores and their impact on vegetation.

Salary — In the region of £9687-£15 823 according to qualifications and experience.

Further details and application form telephone or write to, Personnel Officer, Forestry Commission Research Station, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH. Tel (0420) 22255, Ext 206/213. Closing date, 11 July, 1988.

Equal Opportunity Employer.

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SUBIS is self-financing. It succeeds by taking initiative in responding to the changing needs of 3,000 scientists world-wide. Approximate new information technology is being introduced rapidly.

The salary will be on the scale for Research & Analogous Staff, Grade IB, £8675-£11 680 per annum, at an appropriate point, according to age, qualifications and experience.

The appointment will be for two and a half years initially, starting in August or September, 1988.

Informal enquiries should be made to the Director of SUBIS (0742-76855; Ext 6231 or 6233). The University, Sheffield S10 2TN to whom applications, a cv and the names of two referees should be sent to arrive by 18 July, 1988. Please quote Ref MAP041/H.

An Equal Opportunity Employer

SURREY COUNTY COUNCIL

North East Surrey College of Technology

Reigate Road, Ewell, Epsom, Surrey KT17 3DS

Applications are invited for the following post to be filled with effect from 1 September, 1988:

Department of Construction Studies

LECTURER/SENIOR LECTURER IN ACOUSTICS AND NOISE CONTROL

The post has arisen because the College has been awarded a one-year contract by the Manpower Services Commission to investigate training needs in Hearing Conservation and Noise Control. The successful applicant will work with the Project Manager on the contract and also assist with lecturing in Acoustics and Noise Control to the Institute of Acoustics Diploma course.

Applicants should be educated to degree level or equivalent, and have a qualification in Acoustics and Noise Control. The ability to liaise effectively with industry will form a very important part of the job and suitable experience will be an advantage to applicants.

Intending applicants may telephone 01-394 1731, Ext 380 Mr E. G. Davies or Ext 385 Dr R. J. Peters for an informal discussion prior to making application.

Salary Scale: Senior Lecturer £15 369-£18 549 pa. Lecturer £2481-£15 369 pa. Plus London Fringe Allowance.

Further information about the post and application forms can be obtained from the Vice-Principal, NESOC, Reigate Road, Ewell, Epsom, Surrey KT17 3DS. Please send a large stamped addressed envelope.

UNIVERSITY OF WALES



STATISTICAL ADVISOR

(fixed term—three years)

To provide advice on statistical analysis, experimental design and similar topics, and to assist staff and students in the use of statistical software, particularly SPSS-X and MINITAB.

Applicants for this vital post should have a good knowledge of basic statistical techniques and experience in the use of computers. Further training will be given if necessary.

Salary £8675-£11 680 pa or £12 150-£15 720 pa.

Requests (quoting Ref F81) for details and application form to Personnel Section, UWIST, PO Box 68, Cardiff CF1 3XA.

Closing date: 21 July, 1988.

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Ring NOW for further information, which could lead to an immediate local interview.

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The Ethical Register
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309 Reading Road
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Oxon RG9 1EL
(0491) 571888

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Applicants will preferably be life science or pharmacy graduates but others with relevant experience will be considered and appropriate training given. You must be willing to undertake travel both in the UK and Europe.

As well as an attractive salary, we offer a benefits package you would expect from a major, progressive company, including profit-share, pension and staff discount schemes. A generous relocation package is available where appropriate.

Please send full c.v., stating current salary, to Mr. T. W. Flower, Employment Manager (Technical), The Boots Company PLC, Station Street, Nottingham NG2 3AA.



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We are seeking to recruit a recently qualified

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You will be working in modern laboratories which are equipped to handle the analysis of all metals, both precious and base, utilising a variety of both classical and instrumental methods.

We offer a competitive salary, generous holiday entitlement and free lunches.

For further information and an application form, please telephone The Personnel Officer on 01-804 8111, Ext 227.

Johnson Matthey PLC
Jeffreys Road, Brimsdown,
Enfield, Middlesex
EN3 7PW.

NORTH WEST SURREY DISTRICT LABORATORY

St Peter's Hospital, Chertsey, Surrey

Medical Microbiology
MEDICAL LABORATORY SCIENTIFIC OFFICER
Applicants must be state registered and will be encouraged to take part in the emergency duty rota. Whitley Council conditions of service apply, including £149 pa fringe allowance. Excellent working conditions in a modern laboratory.

Post available from mid-September '88. Closing date 1 August, 1988. For further information and application form contact Mr A. Peacock, Chief MISO, Microbiology Department, St Peter's Hospital, Guildford Road, Chertsey, Surrey KT16 0PZ. Tel 093287 2345, Ext. 29.

UNIVERSITY OF GLASGOW

Department of Biochemistry

POSTGRADUATE AND POSTDOCTORAL RESEARCH ASSISTANTS

to work on DNA Methylation in Eukaryotes.

Two research assistants want work on MRC supported projects. One (Grade 1B or 1A) will work on the cloning and analysis of DNA methylation genes and should preferably have experience in DNA manipulation. The second (Grade 1B) will study the effect of restriction and transformation of cells with herpes virus on the DNA methylation of the host cell. It may be possible for the second assistant to register for a higher degree.

Applications, together with a cv and the names and addresses of two referees should be sent to Dr R. L. P. Adams, Department of Biochemistry, University of Glasgow, Glasgow G12 8QQ.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE



Senior Soil Chemist Senior Scientist in Alley Farming

The International Institute of Tropical Agriculture (IITA) at Ibadan, Nigeria invites applications from highly qualified scientists for the two senior positions of Soil Chemist, in its Resources and Crop Management Program, and Coordinator, Alley Farming Network for Tropical Africa (AFNETA).

IITA is an international agricultural research and training center, one of a consortium of 13 such centers world-wide which was organized by the World Bank, Food and Agriculture Organization of the United Nations and the United Nations Development Program. With headquarters on a 1,000-hectare campus and experimental farm, IITA has outreach programs in many sub-Saharan African countries and employs some 200 internationally recruited staff members from 45 countries.

The Soil Chemist will be responsible for:

- ★ Development and coordination of research emphasizing the management of upland and tropical soils in collaboration with scientists in related disciplines. The research will include:
 - chemical characterization and inventory of benchmark soils in the region, their potential and constraints for crop production.
 - nutrient dynamics and balances.
 - soil chemical aspects of nutrient deficiencies and toxicities.
 - aluminum chemistry of highly weathered kaolinitic soils.
 - Chemistry of organic matter decomposition.
 - Management of acid soils in relation to various cropping systems.

- ★ Supervision of postdoctoral fellows and participation in training programs.

Candidates should hold a doctorate or equivalent distinction in soil chemistry; have had a minimum of four years of experience in research on tropical soils; have some knowledge of French; be willing to travel frequently throughout sub-Saharan Africa. The successful candidate, after an initial assignment at IITA headquarters, will be transferred to a planned substation for the humid forest acid soil zone, to be located in a francophone country in West or Central Africa.

The Coordinator, AFNETA will:

- ★ Act as secretary and implement the decisions of the AFNETA Steering Committee and the members' assembly.
- ★ Provide national researchers with help to establish their programs and with technical advice and assistance in their research activities, including organization of training.
- ★ Prepare periodic newsletter(s), edit reports and other documents as required.
- ★ Maintain close collaboration with various agencies and networks.

Candidates should hold a doctorate or equivalent distinction in a relevant scientific discipline, have had a minimum of four years of experience in alley farming or agroforestry research in Africa; have had some experience in research management; have competence in technical writing; be fluent in both English and French. The successful candidate will be based at IITA Headquarters at Ibadan and will travel on assignment throughout sub-Saharan Africa.

AFNETA is a collaborative research network between national research centers in tropical Africa, IITA, the International Livestock Center for Africa (ILCA), the International Council for Research in Agro-Forestry (ICRAF) and other international research centers. AFNETA's objectives are to (a) promote discussion and research on alley farming and similar improved methodologies, (b) test technologies developed and the use of concepts across diverse environments in tropical Africa and (c) encourage inter- and intra-country cooperation to support those objectives.

Salaries are paid in US dollars and are determined on the basis of qualifications and experience. IITA offers a liberal package of benefits including alternative pension schemes, group life and health insurance, annual home leave travel, children's educational grants and travel, among others. Accommodation is provided in a beautiful campus environment with recreational facilities.

Application for these two senior scientist positions should include a statement of research interest, curriculum vitae, names and addresses of three referees (including telephone and telex number if available) and other pertinent information. Applications should be sent to either of the following addresses:

Manager, Human Resources (IITA) OR
c/o Lamburn and Co., Ltd.
26 Dingwall Road
Croydon CR9 3EE
United Kingdom

Manager, Human Resources
IITA
Oyo Road, PMB 5320
Ibadan
Nigeria

UNIVERSITY OF WALES



WELSH SCHOOL OF PHARMACY CANCER RESEARCH CAMPAIGN

POSTDOCTORAL RESEARCH ASSISTANTS

1) RESEARCH ASSISTANT—Fixed Term—three years (Ref F.86)

For pharmaceutical investigations with novel aromatase inhibitors. A background in a biomedical discipline is necessary and experience with enzymes, radioisotopes and HPLC is desirable.

2) RESEARCH ASSISTANT—Fixed Term—18 months (Ref F87)

For the design and synthesis of novel heterocyclic compounds as potential inhibitors of steroid biosynthesis. A background in synthetic medicinal or pharmaceutical chemistry is necessary.

Salary: Within Research and Analogous Staff Range 1A £9865-£15 720 pa.

Requests for details and application form, quoting appropriate Ref No., to the Personnel Office, c/o UWIST, PO Box 68, Cardiff CF1 3XA. Closing date: 31 July, 1988.

THE MACAULAY LAND USE RESEARCH INSTITUTE-ABERDEEN

Land Use Division

LAND USE MODELLER (SSO/GU7)

This new post will develop the Institute's remit in land use research. The appointee will take a leading role in a team which has responsibility for examining a wide range of land use and land use options. He/she will be responsible for the design of modelling systems to integrate the complex interactions occurring between the physical, environmental, agricultural and silvicultural production systems and the economic and sociological elements of land use. Close collaboration with research scientists in all these fields will be necessary.

In addition, the appointee will have a major input in the development of the Institute's Land Use Information System. The appointee will collaborate closely with the Scottish Agricultural Statistics Service in these developments. A working knowledge of the primary issues in land use in the United Kingdom will be required.

Candidates should possess a higher degree in mathematics or computing science, with proven systems design experience. A biological or geographic background will be an advantage.

Salary will be within the range SSO £12 024-£16 823 per annum; UG7 £15 630-£20 292 per annum. Non-contributory superannuation scheme operative. MLUR is an Equal Opportunities Employer.

Forms of application and further information may be obtained from The Secretary, The Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen, AB9 2QJ, to whom they should be returned by 18 July, 1988. Quota Ref. MA7/88.

UNIVERSITY OF WALES

DEPARTMENT OF
EDUCATIONLectureship in
Educational
Management
(Fixed-term—Three
Years)

Applicants will be expected to have a wide knowledge of organisation and management theory and its application to education contexts. Relevant practical experience of management, consultancy and research within these areas is of great importance. An interest in the policy and practical implications of the move toward more local financial and other forms of control in the educational system is essential.

Salary:
Lecturer A—£3260-£14 500 pa
Lecturer B—£15 150-£19 310 pa
Requests (quoting Ref No. 88/34)
for details and application form to:
Personnel Office, c/o UWAIST, PO
Box 68, Cardiff CF1 3XA.
Closing Date: 14 July, 1988

ST GEORGE'S HOSPITAL
MEDICAL SCHOOL
(University of London)Department of Histopathology
MISO (CYTOLOGY)

A state registered MISO, who has particular interest in Cytology is required to work in this busy cytology department which provides a District Service. Gynaecological and a wide range of non-gynaecological specimens are processed including fluid cytology, breast, FNA's and immunocytochemistry. Salary from £7887-£10 636 (including London Allowance), depending on skills and experience. There will also be an opportunity to gain experience in general Histopathology.

Enquiries to: Mrs J. Heath,
Senior Chief MISO (Tel 01-672
9944, Ext 55268).

Further particulars and an application form from the Personnel Officer, St George's Hospital Medical School Cranmer Terrace, London SW17 0RE. Tel 01-672 9944, Ext 56020. Closing date 31 July, 1988. Quote Ref 92/88.

DEVON WILDLIFE TRUST

Requires Project Officer for one year. Must have field work and report writing experience. Salary £7250.

Details from DWT 35 New Bridge St., Exeter EX4 3AM. Closing date July 15th.

OVERSEAS DEVELOPMENT
ADMINISTRATION AND
UNIVERSITY OF BRISTOLTsetse Research Laboratory
ENTOMOLOGIST

Applications are invited for a two year postdoctoral appointment, with the possibility of extension for a third year, funded by the Overseas Development Administration. Prior experience of tsetse flies or of work overseas is desirable but not essential. After periods of familiarisation at the Tsetse Research Laboratory and in Zimbabwe, the successful applicant will be based at the Kenya Trypanosomiasis Research Institute and will undertake behaviour-orientated research on populations of tsetse flies. This will involve extended periods of field work. A University salary on the scale £9865-£15 720 pa, subject to UK Income Tax, will be paid, with a tax-free overseas allowance, housing allowance and other benefits while working overseas.

Reply with cv and the names of two referees by 20 August, 1988 to The Director, Tsetse Research Laboratory, Langford House, Langford, Bristol BS18 7DU.

FORESTRY COMMISSION
RESEARCH STATION

Alice Holt Lodge, Wrecclesham,

Farnham, Surrey
Applications are invited for the post of

ENTOMOLOGIST

The appointee will be concerned primarily with the establishment of a new project on the impact of insects on tree growth. Experimental and survey work in the field will form an important part of this study.

Qualifications — Applicants should possess a degree or equivalent in a biological subject and preferably should have post graduate experience in insect/plant relations.

Salary — In the region of £8284-£13 005 according to qualifications and experience.

Further details and application form (telephone or write to: Personnel Office, Forestry Commission Research Division, Alice Holt Lodge, Wrecclesham, Farnham, Surrey GU10 4LH. Tel (0420) 22255, Ext 206/213. Closing date, 22 July, 1988.

Equal Opportunity Employer.

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operates a smoking policy, details
of which will be sent to shortlisted
candidates.

MEDICAL LABORATORY
SCIENTIFIC OFFICERS

Applications are invited for two full-time posts in the joint PHL/DHA Department of Microbiology, which currently handles about 150 000 specimens per year. Both positions are ideally suited to State Registered MLSCOs, but consideration will be given to graduates or A level candidates. Successful applicants will have the opportunity to work in all sections of the Laboratory, including Environmental and Virology sections. Good facilities for training and further study are available. A busy on-call service operates (for suitably qualified staff).

Further information from Mr J. S. KENNEDY, MISO, Tel Reading (0734) 863115.

Application forms and job descriptions obtainable from Mr B. Walsh, PMLSO, Department of Pathology, South Wing, Royal Berkshire Hospital, London Road, Reading, RG1 5AN, Tel Reading 861957, Ext 33. Closing date: 22 July, 1988.

Pathology Laboratory,
Haematology Department
MISO/JUNIOR MISO

to work in a large, very busy and extensively automated department. Excellent opportunities of studying for HNC/PIMLS examinations.

Applicants should possess an appropriate Science degree or two A levels, one of which should be Chemistry or Biology.

Job descriptions and application forms from Mr B. S. Walsh, PMLSO, Tel Reading (0734) 861957, Ext 33.

Further details from Mr J. Richmond, Senior Chief MISO, Tel Reading (0734) 861957, Ext 48. Closing date: 20 July, 1988.

PUBLIC HEALTH
LABORATORY SERVICE
BOARD

Public Health Laboratory,
Central Middlesex Hospital
ELECTRON MICROSCOPE
PRINCIPAL
MICROBIOLOGIST

Applications are invited for the above post which will become available in September. The person appointed will be responsible for the diagnostic service and research aspects of electron microscopy and will also be expected to take a leading part in developing new technology in relation to viral detection and identification.

Arrangements to visit the department and further details may be obtained from the Director, Dr D. A. McSwiggan, Public Health Laboratory, Central Middlesex Hospital, Acton Lane, Park Royal, London NW10 7NS. Tel 01-965 1603.

Salary scale: £14 389-£19 895 plus £718 London Weighting pa. Closing date: 21 July, 1988.

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FELLOWSHIPS, GRANTS & SCHOLARSHIPS

Syntax Research Centre

POSTDOCTORAL RESEARCH FELLOWSHIP

A postdoctoral research position is available to work in a small electro-physiology group within the Pharmacology department. The research of the unit is centred on CVS and CNS areas and enjoys close research links with University department in Edinburgh and Glasgow.

Research project is concerned with the evaluation of the mechanism of action of drugs using electrophysiological and ionic measurement techniques. Preferred candidates will have recently completed or be about to complete their PhD and should have some relevant experience although consideration will be given to anyone interested in learning intracellular recording and voltage clamp techniques.

Salary competitive with University scales, Luncheon Vouchers. Fellowship initially for one year.

If interested please send your cv and letter of application to:

Mr A. B. Cran, Director of Personnel, Syntax Research Centre, Heriot-Watt University, Riccarton, Edinburgh EH14 4AP.

UNIVERSITY OF SUSSEX POSTDOCTORAL FELLOWSHIPS ON CHEMISTRY AND PHYSICS IN IONIC LIQUIDS

Applications are invited, from synthetic inorganic chemists skilled in working with air-sensitive compounds and/or the spectroscopic and structural characterisation of inorganic complexes in solution, for two three year postdoctoral fellowships (starting 1 October, 1988; subject to renewal after one year). Successful candidates will join an active research team investigating the chemistry and physics of room-temperature ionic liquids, and will be involved with, inter alia, synthesis, cyclic voltammetry, ESR, photoelectron spectroscopy, NMR, catalytic studies, metal clusters, mixed-valence compounds, and Friedel-Crafts chemistry. The work is completely supported by the Venture Research Unit (BR), and is funded at SERC rates. Salary on Grade 1A scale £9865-£15 720 pa. Applications, including full cv and two nominated referees, should be sent to Dr K. R. Seddon, School of Chemistry and Molecular Sciences, University of Sussex, Palmer, Brighton BN1 9QJ (Tel 0273 676312) by 14 July 1988.

An Equal Opportunity Employer

UNIVERSITY OF BIRMINGHAM Faculty of Engineering

Department of Civil Engineering



Research Fellowship

Applications are invited for the post of Research Fellow (Grade RF1A) to work in the area of numerical analysis of the geometrically non-linear behaviour of thin-walled structures, and to produce associated computer software. Applicants should have PhD in a suitable engineering or related discipline such as Mathematics or Physics and a strong interest in applying computer-based methods to the solution of problems in structural mechanics. The post, funded by the Ministry of Defence, is tenable for up to three years. Salary on RF1A scale of £9865-£15 720 per annum, plus superannuation.

Further particulars from Assistant Registrar (Engineering), PO Box 363, Birmingham B15 2TT, quoting reference Q1, to whom applications (three copies), including full curriculum vitae and naming three referees, should be sent by 8 July, 1988.

AN EQUAL OPPORTUNITIES EMPLOYER.

NUFFIELD FOUNDATION

ONE YEAR SCIENCE RESEARCH FELLOWSHIPS

The Nuffield Foundation is offering to University and Polytechnic Lecturers in Science and Applied Science Departments a number of one-year research fellowships to be awarded competitively at the end of 1988 and to be held during the academic year 1989-90. The objective is to enable younger university lecturers to be freed from teaching and administrative duties for one academic year. Preference will be given to applicants under the age of 40. Awards will cover the cost of replacement teaching (up to the sixth point on the new university lecturer scale) and will include an allowance for research equipment.

The closing date is 1 October, 1988 and further particulars may be obtained from the Nuffield Foundation, 28 Bedford Square, London WC1B 3EG.

This scheme is only open to applicants from Institutions within the United Kingdom.

FRESHWATER BIOLOGICAL ASSOCIATION

Information Science Fellowship

2 YEAR POST GRADUATE/POST MASTERS TRAINING FELLOWSHIP RELATING TO FRESHWATER BIOLOGY AND THE WATER INDUSTRY

Applications are invited for a training fellowship in the Library and Information Services section of the Freshwater Biological Association. The major objectives of the post will be to gain a thorough knowledge of the existing information services relevant to the freshwater sciences and to assess the potential for future services in this changing field.

A good science base with an information qualification at BSc or MSc level combined with an interest/aim for marketing information products are the essential qualifications.

Salary: the salary will be based on the Civil Service Assistant Librarian pay scale. Application forms and further details may be obtained from The Secretary, Freshwater Biological Association, The Ferry House, Ambleside, Cumbria, LA22 0LP. Closing date: 31 July, 1988.

UNIVERSITY OF ABERDEEN

Department of Geology

OCCIDENTAL POSTDOCTORAL RESEARCH FELLOW IN PETROLEUM GEOLOGY

Applications are invited for the newly established Occidental Fellowship in Petroleum Geology. The appointee will work in collaboration with Dr N. H. Trewin of the University Geology Department and the geological team at Occidental Petroleum (Caledonia) Ltd in Aberdeen. Research projects will involve reservoir geology of Jurassic and Cretaceous formations in the Outer Moray Firth. Postgraduate experience of sedimentology, diagenesis and log interpretation is preferred. Publication of results is expected.

Initial appointment will be for one year on a salary scale commencing at £9865. Candidates should be available to start in September 1988.

Further particulars and application forms from The Personnel Office, The University, Regent Walk, Aberdeen AB9 1PX (Tel 0224 273500) to whom applications (two copies) should be returned by 18 July, 1988 (WD/094).

FOR SALE

FOR SALE

New Scientist, vols. 83-116 (inc. Index and Binder). Offers to Box No E16.

SPONSORSHIP

SPONSORSHIP

POST IN POLLUTION ECOLOGY SOUGHT

BSC 2:1 Botany (Reading 87). Field experience in Ecuadorian Rainforests last year. To study for PhD or MSc contact D. Beath, Frost House, Frost Lane, Ilton, Ilminster, Somerset TA19 9EU. Tel 0460 53288.

LECTURES, MEETINGS AND COURSES

ROBERT GORDON'S INSTITUTE OF TECHNOLOGY, ABERDEEN

School of Electronic and Electrical Engineering

POSTGRADUATE DIPLOMA (CNAAP)

In Information Engineering with options in:

- (i) Information Systems Technology, or
- (ii) Computer Technology.

One year retraining course leading to an understanding of either the operation and structure of large scale computers, or computer networks used for information handling.

Applicants should be graduates of a scientific discipline (though not in electrical engineering or computer science). Some grants still available.

Further details and application forms from: Assistant Registrar (Student Administration), Robert Gordon's Institute of Technology, Schoolhill, Aberdeen AB9 1FR. Tel 0224 633611.

OXFORD POLYTECHNIC

School of Biological and Molecular Sciences

Aspects of Biotechnology

An intensive 'hands on' practical and theoretical introduction to recombinant DNA and monoclonal antibody technology in new purpose built laboratories. Suitable for anyone who would like to introduce these subjects into their research and teaching but is unsure how to start.

Course runs 12-16 December, 1988. The course fee is £500 including full board accommodation. For further information, contact Dr N. P. Groome, School of Biological and Molecular Science, Oxford Polytechnic, Gypsy Lane, Headington, Oxford OX3 0BP. Phone 0865 819255.

PORTSMOUTH POLYTECHNIC

MSc IN MICROWAVE SOLID STATE PHYSICS

A one-year sandwich/full-time course with a project in industry or the Polytechnic. Excellent employment prospects.

Course content: Microwave semiconductor devices, materials, transmission, circuits, microwave electronics, design, CAD, Antennas, Entry requirements: Honours degree in Physics, Electrical Engineering, or equivalent.

Finance: Quota SERC awards available + up to £3000 in industry.

Further details: Administrative Assistant, Department of Applied Physics and Physical Electronics, Portsmouth Polytechnic, Portsmouth PO1 2DZ. Tel 0705 827881. Ext. 139.

University of Reading

MSc in APPLIED AND MODERN OPTICS

A wide syllabus in this industrially important subject is covered via a 12-month programme of lectures, labs, workshops, and a dissertation project. Course includes applied areas of electro-optics, lasers, imaging, interference, opto-electronics, and system design. Industrial contact is an important element.

Part-time study is also possible. SERC awards available.

Details: Dr J. Macdonald, Physics Department, PO Box 220, Reading RG6 2AF. Tel (0734) 875123, Ext 464 or 367.

Coleg Prifysgol Cymru Aberystwyth The University College of Wales

Postgraduate Diploma Conversion Course in Computer Science

This is a vocational training course with an emphasis on software engineering. It is intended for graduates in all disciplines with little or no previous experience in computing and aims to provide them with the skills needed to enter the IT industry at professional level. The course runs from September 1988 until June 1989; financial assistance may be available for applicants who are under 25 and without a job.

Details/application forms:

Postgraduate Admissions
University College of Wales
Old College
King Street
Aberystwyth
Dyfed SY23 2AX
(0970) 623177, Ext 212

Closing date for applications: 31 July, 1988.

MSc in Water Pollution Control and PGDip in Air and Water Pollution Control

Part-time, one day and evening a week for two years (MSc), or four terms (PGDip), starting October 1988

Applicants should normally possess a first degree or equivalent professional qualification in a branch of science or engineering.

Ask for
ENQUIRIES on
01-368
1299

or write to: Enquiries (ref C410),
Middlesex Polytechnic, Trent Park,
Barnet, Herts EN4 0PT.

Middlesex Polytechnic

in association with
The Polytechnic of Central London

NEWCASTLE UPON TYNE POLYTECHNIC

MSc Optoelectronics (CNA)

The one year course programme covers Optoelectronics devices, lasers, Fourier optics, microprocessors and computing with laboratory work. In addition an optional choice between image processing or signal processing is offered.

The final 16 weeks of the course is a project carried out in an industrial laboratory.

SERC Advanced Course Studentships are available. In certain cases the MSc can provide financial support.

Further details and application forms from:

Dr J. Laitner
Faculty of Engineering, Science and
Technology
Newcastle upon Tyne Polytechnic
Elston Place
Newcastle upon Tyne
NE1 8ST
Telephone: (091) 232 6002 Ext 3657

KINGSTON POLYTECHNIC

Faculty of Science

GRADUATESHIP OF THE ROYAL SOCIETY OF CHEMISTRY

One year full-time course

The course enables successful candidates to gain a qualification equivalent to a good Honours degree in Chemistry and to use the designation Chem. MRSC. Applicants should hold a BSc degree with chemistry as a main subject or GRSC Part 1, and may be eligible for a LEA grant.

Enquiries to: Faculty of
Science Office, Kingston Polytechnic,
Penrhyn Road,
Kingston upon Thames, KT1 2EE.
Tel 01-549 1366.

UNIVERSITY OF LEICESTER

TRAINING PROGRAMMES IN NEW TECHNOLOGIES

The University of Leicester is able to offer special one year training programmes leading to certificates in the following areas:

Information Technology (Ref 2496).

Biotechnology (Ref 2497).

Includes Genetic/Protein/Enzyme Engineering, Microbiotechnology, Analytical Techniques, Cytological Techniques and Plant Biotechnology.

Electronic Systems (Ref 2499).

The programmes offer advanced training with a vocational bias, and are particularly appropriate for candidates whose present qualifications have prevented them from obtaining employment in areas where these technologies are required.

Courses will last from 48 weeks beginning in late August 1988. Candidates must be aged 19-24. A first degree may be advantageous but is not obligatory. Successful and suitably qualified trainees may also be able to register separately for higher degrees, for which the Certificate will be a credit. Financial support will be available.

For further details of the programmes, the specialist options available within them, and for application forms, write to the following quoting the reference number for the programme given above: Higher Degrees Office, University of Leicester, Leicester LE1 7RH.

UNIVERSITY OF GLASGOW

The West of Scotland College
Hannah Research Institute

MSc/POSTGRADUATE DIPLOMA IN RUMINANT SCIENCE

(Beef and dairy cattle,
sheep, goats and deer).

These courses provide advanced training for recent graduates or experienced scientists who have a professional interest in ruminant animals and who wish to extend their knowledge of current developments in applied ruminant science. The courses aim to develop each candidate's skills in scientific research as well as emphasising the relationship between scientific research and technological development. The Diploma course runs for nine months from October to June whilst the MSc Course includes an additional research project which extends the duration of the course to a minimum of one calendar year and a maximum of two academic years.

A MAFF Advanced Course Studentship is available covering course fees and maintenance allowance.

Further details may be obtained from: Dr D. I. West, Animal & Food Science Division, Cronin Building, The West of Scotland College, Auchincruive, Ayr KA8 5HW. Tel: (0292) 520331, Ext 350.

Interviews will be held on the 19 July, 1988. Letters of application with full cv should be sent to Dr West to arrive not later than 11 July, 1988.

SCHOOL OF HYPNOSIS

Diploma courses W/E 01-359 6991

BUSINESS OPPORTUNITIES

START AN IMPORT/EXPORT AGENCY from home part- or full-time. No capital, no risk. Send 18p stamp for free 24-page booklet. Import Ltd, PO Box 334 London W5.

OVERSEAS

US EMPLOYMENT

See or cv Venture America, 128 Balfour Tower, Hamelin Street, London E14 9QT.

STUDENTSIPS

AFRC INSTITUTE OF PLANT SCIENCE RESEARCH

Nitrogen Fixation Laboratory

University of Sussex

RESEARCH STUDENTSHIP IN INORGANIC CHEMISTRY

A research studentship, tenable for three years and leading to a DPhil degree to be available from 1 October, 1988, at the above multi-disciplinary research establishment.

The successful applicant will study the binding and activation of small molecules at vanadium-sulphur sites, and the work will include both synthetic and mechanistic chemistry. This project provides an opportunity to do innovative research in the new and exciting area of vanadium chemistry related to the alternative vanadium-containing nitrogenase.

The candidate will be expected to have or obtain a first or upper second class honours degree in an appropriate subject.

Applications including a cv and the names of two referees should be sent without delay to: Mrs J. A. Durrant, AFRC-IPSR Nitrogen Fixation Laboratory, University of Sussex, Brighton BN1 9RQ.

The Agricultural & Food Research Council is an Equal Opportunities Employer.

AFRC INSTITUTE OF ARABLE CROPS RESEARCH

Rothamsted Experimental Station, Harpenden, Herts AL5 2JQ

PhD STUDENTSHIP

Applications are invited from those possessing or expecting to obtain a first or upper second class Honours degree in Biological or Plant Sciences. The research project is to investigate induced resistance to fungal pathogens in cereals and biochemical changes associated with this resistance.

The project is funded for a period of three years from 1 October, 1988 by the Agricultural Genetics Company.

Applications, including a cv and the names of two referees should be sent to The Secretary quoting Ref 756 by 29 July.

UNIVERSITY OF MANCHESTER

NERC CASE STUDENTSHIP

Radionuclide Uptake, Transport and Effect on Bacteria

A special topic studentship prompted by the arrival of Chernobyl radionuclides in Britain, which will examine the interaction between radionuclides and perennial plants. The work would involve the controlled application and analysis of radionuclides, and could include DNA cloning and analytical techniques, depending on the interests of the student. The project will be supervised by Dr E. Sheffield (Plant Science and Cytogenetics Group) and Dr T. V. Callaghan (Institute of Terrestrial Ecology, Merlewood) and would be suitable for a graduate with a 1st or upper 2nd class Honours degree in botany, biology, biochemistry or a related subject.

Applications, including a full cv and the names and telephone number of two referees, should be sent as soon as possible to Dr E. Sheffield, Department of Cell and Structural Biology, Williamson Building, University of Manchester, Manchester M13 9PL, who can also be contacted for more information on 061-275 3905.

THE UNIVERSITY OF LEEDS

Department of Inorganic and Structural Chemistry and Unilever Research

Research Studentship

Applications are invited for an SERC CASE Research Studentship leading to the degree of PhD in SOLID STATE CHEMISTRY. Candidates should hold, or expect to obtain, a Class I or II(i) Honours Degree in Chemistry, Physics or Materials Science.

The project will involve the synthesis of novel perovskites and their structural characterisation by Mossbauer spectroscopy, and diffraction techniques (in Leeds, supervised by Drs P. D. Battle and T. C. Gibb) and an assessment of their surface properties and catalytic activity (at Unilever, Dr S. W. Carr).

Further details can be obtained from Dr Battle, Department of Inorganic and Structural Chemistry, Leeds University, Leeds LS2 9JT.

UNIVERSITY OF CAMBRIDGE

Department of Physics

SERC CASE

and other studentships for PhD research are available for eligible and qualified applicants in the following topics:

Computer simulation of random cellular materials. The use of focused ions as matrix and dopant sources in MBE growth. Interfacial polymer layers probed by neutron reflection spectroscopy. Characterisation of interfaces in particle-containing alloys.

For further information and arrangements for interview, please telephone Mr J. Deakin (0223 337421) or write to him at the Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE.

UNIVERSITY OF LIVERPOOL

Department of Botany

RESEARCH STUDENTSHIPS

Applications are invited for the following SERC Studentships tenable for three years from October, 1988.

(a) Immunological approaches to studies on metal-binding peptides of plants and fungi (supervised by Dr D. A. Thurman).

(b) Extracellular nitrite release by microalgae (supervised by Dr H. W. Pearson).

(c) Mechanisms of host resistance to *Septoria agricola* (supervised by Dr H. A. Collin and Dr S. Isaac).

Applicants should have or expect to obtain a good honours degree in a biological subject.

Applications, including a cv and the names of two referees, should be sent to the appropriate supervisor, Department of Botany, The University, PO Box 147, Liverpool L69 3BX (Tel 061-709 6022).

Further details will be sent to all applicants.

An Equal Opportunity Employer.

HATFIELD POLYTECHNIC

Division of Biological Sciences

RESEARCH STUDENTSHIP

(SERC CASE) IN COLLABORATION WITH SK AND F RESEARCH LTD. WELWYN, HERTS.

Drug Interactions with Deuterated Calmodulin

This project will involve the purification of deuterated calmodulin from *E. coli* clones containing the calmodulin gene, and the analysis of drug-calmodulin interactions using ¹H-NMR spectroscopy and state-of-the-art molecular graphics and computational facilities.

Informal enquiries or applications (no forms) to: Dr John Walker, Biological Sciences, Hatfield Polytechnic, Herts AL10 9AB, (0772 79544).

UNIVERSITY OF WARWICK

Department of Engineering

SERC CASE STUDENTSHIP

The highly successful collaboration between the Warwick Centre for Microengineering and Metrology and the National Physical Laboratory is continuing through an award to pursue PhD studies of the fundamental physical mechanisms underlying the production of super-precision surfaces, with minimal surface damage, in brittle ceramics, glasses and single crystal semiconductors.

Candidates should have a good honours degree in a relevant branch of Engineering, Materials Science or Physics. Knowledge of conventional machining processes is not necessary.

Write in the first instance to Dr N. Storey, Department of Engineering, University of Warwick, Coventry CV4 7AL for further details and application forms.

UNIVERSITY OF CAMBRIDGE

Department of Materials, Science and Metallurgy

CASE STUDENTSHIP FOR CHEMIST/BIOCHEMIST Development of Organic Microprobe Analysis

In association with two industrial collaborators, a CASE Research Studentship is available from 1 October, 1988 for research on the development of organic microprobe analysis using laser-induced ionisation and time-of-flight mass spectrometry. This is a new and exciting Mass Spectrometry technique with application as diverse as microprobing pesticides on whole leaf tissues and identifying organic contaminants on semiconductor surfaces. The work would be carried out in an exciting research group, the aims of which include improving the technique and establishing a better basic understanding of it. The project would suit someone with, or about to obtain a degree in chemistry or biochemistry and with an interest in physical analytical techniques applicable to microanalysis of solid organic/biological material.

For further details write to Dr E. R. Wallach, Department of Materials Science and Metallurgy, Pembroke Street, Cambridge CB2 3QZ, UK.

THE LONDON HOSPITAL MEDICAL COLLEGE MRC RESEARCH STUDENTSHIP

Applications are invited from science (medical and dental) graduates for the above position, held jointly in the Departments of Dermatology and Oral Pathology. The position will be supported by the MRC and involve a study of skin and oral mucosal keratinocyte proliferation in response to growth factors, lymphokines and neuropeptides. Applicants should have experience of cell biology or biochemistry and cell or tissue culture.

Informal enquiries may be made either to Dr I. M. Leigh (Tel 01-377 7749) or Dr D. M. Williams (Tel 01-377 7060).

Applications, together with the names of two referees, should be submitted not later than Friday 14 July, 1988 to The Secretary, The London Hospital Medical College, Turner Street, E1 2AD, from whom further particulars may be obtained.

Grant equivalent to SERC + £750 pa for a three year

Research Studentship

leading to a PhD degree, sponsored by KODAK, on the surface chemistry of the photographic process.

Applicants should have a good honours degree in Chemistry or a related science. Applications, including a telephone number where you may be contacted, should be sent as soon as possible to Dr T. M. Hardman, Department of Chemistry, University of Reading, Whiteknights, Reading RG6 2AD.

UNIVERSITY OF LIVERPOOL

Department of Environmental and Evolutionary Biology

Wildlife habitat restoration following development of the onshore oil and gas industry—economics and social implications

Applications are invited for a PhD STUDENTSHIP

on an interdisciplinary collaborative programme of research. The project will examine techniques for the restoration of existing damaged heathland and also investigate new approaches for creation of heathland on areas where it formerly occurred but is now low grade agricultural land. The overall scope of the project will be an interdisciplinary analysis of the social-environmental impacts of the onshore oil and gas industry, the economics of habitat restoration and a scientific study of colonisation and succession within newly created heathland habitat patches.

The project is sponsored by BP International and the work will be based at both ITE Furzebrook Research Station in Dorset and at Liverpool University.

Applicants should hold or expect to gain a first or upper second class Honours degree in an appropriate Biological discipline. Applications including a detailed cv and the names of two academic referees should be sent to: D. P. D. Putwain, Department of Environmental and Evolutionary Biology (Botany), PO Box 147, Liverpool L69 3BX.

Further information and enquiries to Dr P. Putwain at the above address or preferably telephone 051-709 6022. Ext 2086 (Dr P. D. Putwain) or Ext 2392 (Dr A. M. McManus). Evening telephone enquiries may be made to Dr Putwain on 051-336 1211.

The closing date for applications is 12 July, 1988.

An Equal Opportunity Employer.

UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL

Department of Biochemistry

THREE RESEARCH STUDENTSHIPS

In Molecular Cell Biology are available commencing October 1988.

- SERC quota studentship with Dr P. Jones to investigate the expression, structure and function of cytoskeletal proteins using recombinant DNA techniques.
- Two SERC CASE studentships with Prof R. J. Mayer, (i) with the Hannah Research Institute, Ayr, to study protein secretion using transfected mutagenised casein genes, and (ii) with Shell Research Ltd, Sittingbourne, Kent, to examine the expression of genes associated with the cell stress response (including ubiquitin) as a toxicological index.

Further details from the Department of Biochemistry, University of Nottingham Medical School, Queens Medical Centre, Nottingham NG7 2UL, or for (a) Tel 0533-523475, for (b) 0602-421421, (Ext 3494).

DEPARTMENT OF OCEANOGRAPHY SOUTHAMPTON UNIVERSITY

Research Studentship in Chemical Oceanography

Applications are invited for a NERC Research Studentship to work on biogeochemical cycles of trace metals in the North Sea in relation to the behaviour and fate of natural and pollutant inputs. The research is part of the multidisciplinary NERC North Sea Project and is a joint programme between the Department and the Institute of Marine Environmental Research, Plymouth. Applicants should possess a good honours degree in chemistry or a related discipline and have an interest in the application of analytical chemistry to environmental problems. A considerable amount of work at sea will be involved. The studentship can commence immediately.

Further details are available from The Secretary, Department of Oceanography, The University, Southampton SO9 5NH, to whom applications should also be addressed, by 15 July, 1988, quoting reference number 761/JAD.

UNIVERSITY OF WALES COLLEGE OF CARDIFF

Department of Geology

3 PhD Research Studentships

In South Wales Basin Development. Applications are invited for the following studentships, available for three years from October, 1988:

- THE TECTONIC EVOLUTION OF THE BRISTOL CHANNEL BORDERLANDS. Sponsored by Shell Exploration and Development.
- SEISMIC INVESTIGATION OF DEEP CALFIELD STRUCTURE IN THE SOUTH WALES COALFIELD. Sponsored by NERC.
- THERMAL EVOLUTION OF THE SOUTH WALES COALFIELD FORELAND BASIN. Sponsored by NERC.

The last two studentships are tied to a NERC Special Topic—Basins. Dynamic research project: the evolution of the South Wales Coalfield Foreland basin, organised by Dr R. A. Gayer.

Applications, including a cv and names and addresses of two referees, should be sent to the Head of the Department of Geology, University College, Cardiff, PO Box 91, Cardiff CF1 1XL, by 15 July, 1988.

THE UNIVERSITY OF MANCHESTER

Nuffield Radio Astronomy Laboratories

SERC CASE STUDENTSHIP

(an open competition with the British Antarctic Survey) to investigate the structure in the Cosmic Microwave Background which originates in the Big Bang. Following development work at Jodrell Bank a sensitive receiver system will be commissioned at Izaña Observatory, Tenerife. Subsequently the apparatus will be installed and operated at the Haystack Base of the British Antarctic Survey. Further details from the Director, Nuffield Radio Astronomy Laboratories, Jodrell Bank, Macclesfield, Cheshire SK11 9DL.

UNIVERSITY OF LIVERPOOL

THREE RESEARCH STUDENTSHIPS IN GENETICS

Applications are invited for the following studentships:

- A study of chromosome damage in post-Chernobyl sheep, funded by North West Cancer and the Welsh Mountain Sheep Society (supervisor Dr J. J. B. Gill).
- Molecular genetics of the biosynthesis of the antibiotic diguanide-mycin produced by *Streptomyces hygroscopicus*. University of Liverpool funded (supervisor Prof D. A. Ritchie).
- An SERC quota studentship is available in any of the following areas: the application of molecular and structural analyses to diagnostic human cytogenetics; chromatin structure and gene activation; chromosomal change in the evolution of plants; molecular genetics of nitrogen metabolic repression, pH regulation, DNA repair and recombination and metal tolerance in *Aspergillus nidulans*; higher plant molecular biology; mosquito developmental genetics; DNA repair and mutation in *E. coli* and *Streptomyces* spp.; antibiotic biosynthesis and resistance in *Streptomyces* spp.; heavy metal resistance in isolates from metal-contaminated environments.

Candidates should hold or expect to obtain a First or Upper Second class Honours in Genetics or a related Biological discipline. Applications should include a full cv and the names of two academic referees. For further details of projects, see the Compendium of Research Topics (mini-UCOA) in your department, and enquiries/applications should be made, as soon as possible, to Dr A. B. Tomsett, Department of Genetics, University of Liverpool, PO Box 147, Liverpool L69 3BX. Tel 051-709 6022. Ext 3110 or 3114.

UNIVERSITY COLLEGE LONDON

SERC CASE STUDENTSHIP IN ALLERGY

Applications are invited for this PhD research position, jointly supervised by Dr J. Pearce, University College London and Dr K. J. Murray, Smith Kline and French Research Ltd. The project concerns study of the control mechanisms involved in the release of mediators from tissue mast cells, with particular reference to the roles of cyclic nucleotides, protein kinases, phosphodiesterase isoenzymes and protein phosphorylation, and the relevance of these processes to the treatment of allergic and inflammatory disease. The studentship is tenable from October, 1988 and applicants should have or expect to obtain a First or Upper Second Class Honours Degree in Pharmacology, Biochemistry or a related discipline.

Applications with cv and the names of two academic referees, should be made to Dr F. L. Pearce, Department of Chemistry, University College London, 20 Gordon Street, London WC1H 0AJ. Informal enquiries may be made to Dr Pearce: Tel 01-387 7050, Ext 4689.

UNIVERSITY OF LANCASTER

Department of Chemistry

SERC EARMARKED STUDENTSHIP

Applications are invited from UK citizens who possess a 2:1 Honours degree or better in Chemistry for the following SERC Earmarked Studentships.

- Molecular Recognition and Intermolecular Interactions. This project is concerned with a study of host systems displaying guest selectivity using the techniques of FR-IR, Raman and solid state NMR spectroscopy, under the direction of Dr J. E. D. Davies.

2. Development of Polymeric Langmuir-Blodgett Films. This project is concerned with the preparation of bilayers and multilayers prepared from preformed amphiphilic polymers and their applications as stable models of biomembranes. It will best suit an organic chemist who will work in collaboration with Prof P. Hodge.

Several other quota and CASE awards in polymer science are available.

Applications should be addressed to Prof Hodge or Dr Davies, Department of Chemistry, University of Lancaster, Lancaster LA1 4YA. (Tel 0524-65201, Ext 4089).

UNIVERSITY OF DUNDEE

Department of Chemistry

RESEARCH STUDENTSHIPS

Research Studentships leading to the degree of PhD are available in the following areas, starting October 1989:

- Infrared Study of CO/H₂ reactions over Rh and Rh/Ru Catalysts (Prof C. H. Rochester).
 - Characterisation of Surface Sites by resonance Raman Spectroscopy of probe molecules (Dr T. D. Brown).
 - Applications of novel α -alkoxyphosphine oxides in organic synthesis (Dr A. W. Murray).
- Applicants, who should hold (or expect to obtain) a First or Upper Second Class Honours degree in Chemistry or a closely-related subject should contact the appropriate supervisor at Department of Chemistry, The University, Dundee DD1 4HN (Tel 0382 23181, Ext 4328).

THE UNIVERSITY OF SHEFFIELD

SERC Studentship in Photosynthesis

Applications are invited for an SERC funded studentship to be jointly supervised by Dr R. Horton and R. C. Leegood in the Departments of Biochemistry and Plant Sciences. The research will consider the regulation of electron transport and carbon assimilation in plant photosynthesis upon changes of light and CO₂ and will involve combined biochemical, biochemical and molecular techniques. Applicants should possess a class I or II degree. Applications, including a cv and names of two referees, should be sent to Dr P. Horton, Department of Biochemistry, The University, Sheffield S10 2TN as soon as possible and before 8 July, 1988.

ROYAL POSTGRADUATE MEDICAL SCHOOL (University of London)

Department of Medical Physics SERC STUDENTSHIP

Applications for the above post are invited from suitably qualified graduates, or from students who expect to graduate this year. The person appointed will join the Diagnostic Imaging Section of the department to work on a research project in the physics of medical imaging. The Department of Medical Physics is an integrated department of the Royal Postgraduate Medical School and Hammersmith Hospital. The department is actively engaged in image-processing research and just installed a Cointextvision CQP-302 computer system. The Hammersmith Hospital is currently considering the installation of a full Picture Archiving and Communications System for medical radiology throughout the hospital.

Applicants will require a good first degree, or expect to be awarded one. A background in physics, computing and/or electronics will be an advantage. Relevant research experience and familiarity with the techniques involved is not essential. The person appointed will be expected to register for a PhD. The post is tenable for three years for a mutually convenient starting date in the autumn at the initial salary of £3492 pa.

Applicants should send their cv with the names and addresses of two academic referees to Prof R. Wootton, Department of Medical Physics, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 0NN.

UNIVERSITY OF NOTTINGHAM

Department of Physics SHELL RESEARCH FELLOWSHIP IN NMR MICROSCOPY

Applications are invited from suitably qualified chemists/biochemists for the Shell Research Fellowship in NMR Microscopy. The successful candidate will be involved in the use of a novel NMR microscope which is being constructed with support from the Royal Society Paul Instrument Fund.

The position starting in October is for one year in the first instance with possibilities for renewal.

The project involves the exciting new science of NMR imaging and spectroscopy as applied to the study of microscopic biological and non-biological systems; for example intra cellular metabolic processes, also fluid ingress and dynamics in solid/liquid systems. Applicants should have a PhD or equivalent in chemistry and/or biochemistry. Some experience in NMR imaging or spectroscopy would be an advantage.

Salary will be in the range £9865-£12,000 plus U.K. tax.

Applications including a cv and names and addresses of two referees should be sent to Prof P. Mansfield by 15 July, 1988, University of Nottingham, University Park, Nottingham NG7 2RD.

BRITISH MUSEUM (Natural History)

POSTGRADUATE RESEARCH STUDENTSHIP 1988

A studentship will be available, tenable for three years, at the British Museum (Natural History) commencing October 1988. This will involve joint supervision by the adjacent Dept. of Biochemistry, Imperial College, and higher degree registration with London University.

Department of Entomology

Medical Diptera Group, WHO Collaborating Centre

The project is an experimental study of the diagnostic and taxonomic value of repetitive DNA elements in phlebotomine sandflies, with particular reference to vectors of *Leishmania* of medical importance.

Eligibility

Applicants must be ordinarily resident in Great Britain, and have a first or upper second class honours degree, with final year courses in molecular biology and/or genetics. Those interested in applying may contact Dr P. D. Ready (01-938 9356) or Dr D. F. Smith (01-589 5111, Ext 4159) for further information, and should write to the Secretary (Postgraduate Studentships), British Museum (Natural History), Cromwell Road, London SW7 5BD for application forms, conditions of award and detailed information.

Closing date for receipt of completed application forms 18 July, 1988.

UMIST

RESEARCH STUDENTSHIPS

Applications are invited for PhD Studentships in the Department of Instrumentation and Analytical Science (DIAS) in the following fields:

- ★ Sensitisation of Analytical chemical reactions; Production of stable substrates for optical chemical sensors (Dr R. Narayanaswamy).
- ★ Laser techniques in Analytical Chemistry; Plasma emission spectrometry (Dr R. D. Snook).
- ★ Electroanalytical measurement systems; Automated Flow Injection Analysis (Dr P. R. Fielden).

Applicants for studentships should be UK citizens and should possess, or expect to obtain soon, a first or upper second class honours degree in chemistry (Physical or Analytical) or in another relevant discipline. Postgraduate research grants are available via SERC Earmarked and Quota studentships.

For further information, please contact the appropriate supervisor as soon as possible, at DIAS, UMIST, PO Box 88, Manchester M60 1QD. Tel 061-236 3311.

INSTITUTE OF NEUROLOGY

Department of Neurophysiology RESEARCH STUDENTSHIP

A postgraduate studentship is available in the field of neuromuscular physiology and pathology. Applicants should have, or expect to obtain, a good honours degree in physiology or pharmacology. Applications including cv and the names and addresses of two referees should be sent to Prof L. W. Duchon, Department of Neurophysiology, Institute of Neurology, Queen Square, London WC1N 3BG. Informal enquiries can be made to Dr G. Brook (Tel 01-837 3611, Ext 4234).

UNIVERSITY OF KEELE

Department of Biological Sciences

NERC PHD STUDENTSHIP IN FISH PARASITOLOGY/IMMUNOLOGY

Applications are invited from candidates who hold, or expect to obtain, a first or upper second class honours degree in a biological discipline to study the humoral immune response of cyprinid fish to the cestode, *Ligula intestinalis*.

Enquiries to Dr D. Hoole (Tel 0782 621111, Ext 3096) as soon as possible.

UNIVERSITY OF LIVERPOOL

IRC Surface Science

RESEARCH STUDENTSHIP

A number of PhD studentships are available associated with the newly created Interdisciplinary Research Centre for Surface Science. The Centre has been created by SERC to provide a focus for surface science research in the UK. The Centre's principal scientists are drawn from the Departments of Chemistry, Physics, Electrical Engineering and Materials Science at Liverpool and from the Department of Chemistry at Manchester. They will collaborate with other groups around the country. SERC funding (ca £8M) has been provided, initially for six years, and includes provision for a beam line at the nearby Daresbury Laboratory, dedicated to surface studies using synchrotron radiation. The research programme in the IRC will focus on four main areas: Interfaces and Semiconductor Surface Chemistry, Gas-Surface Reaction Dynamics, Behaviour of Oxide Surfaces, Surface Science and Catalysis Design.

Techniques used in the Centre will include SEXAFS, NEXAFS, angle-resolved photoemission and inverse photoemission, scanning Auger, SPA-LEED, FTIR, STM, laser multiphoton ionisation spectroscopy, classical and quantum scattering calculations, atom/molecule scattering and HREELS.

Further information about the Centre and specific research projects can be obtained from: Prof N. V. Richardson, Donnan Laboratories, University of Liverpool, Liverpool L69 3BX.

UNIVERSITY OF BRISTOL

Department of Zoology

THREE-YEAR RESEARCH STUDENTSHIP (PHD)

available to study the behavioural ecology of brown hares living in coniferous woodlands. The field work will be undertaken in Suffolk and the project is funded by the Vincent Wildlife Trust. Applicants must have, or expect to obtain, a good honours degree, an interest in field work and good analytical and computational skills. Applications with cv and names of two referees as soon as possible to: Dr S. Harris, Department of Zoology, University of Bristol, Woodland Road, Bristol BS8 1UG, who will also supply further details of the work involved.

LIVERPOOL POLYTECHNIC SCHOOL OF PHARMACY

RESEARCH STUDENTSHIP IN PHARMACEUTICAL TECHNOLOGY

Applications are invited from graduates (or students who expect to graduate this year) in chemistry, physics, chemical engineering, pharmacy or a related discipline for a SERC Research Studentship in Pharmaceutical Technology. The research project will be concerned with investigating the effect of compaction speed on the physical properties of tablets, and is primarily using the new compaction simulator developed by Liverpool Polytechnic and supported by Roche Products Ltd, Welwyn Garden City, where part of the study will be undertaken.

Please apply to: Professor M. H. Rubinstein, School of Pharmacy, Liverpool Polytechnic, Byrom Street, Liverpool L3 3AF. Tel 051-207 3581, Ext 2068.

UNIVERSITY OF GLASGOW

Department of Electronics and Electrical Engineering
Recognised by the UGC for the International standard
of its research activities

PhD RESEARCH

Applications are invited from Final-year Honours students and graduates with good Honours degrees in Electrical Engineering, Physics, Mathematics, Materials Science or a related subject. The following SERC CASE projects are offered:

- Rare-earth-doped silica integrated waveguide lasers
 - Silicon optical waveguide device technology
 - Components for optical thin-film signal processors
 - Excitons and phonons in zero-dimensional semiconductor
 - Verification of analytical models for hot-electron transport in semiconductor devices
 - Scattering rates in semiconductor electron transport
 - Optimisation of switched capacitor filter structures
 - Robust validation tools for helicopter flight mechanics modelling
 - Optimisation studies on a hydro-turbine controller
- For more information and application form write to Professor P. J. R. Laybourn, Dept Electronics and Electrical Engineering, University of Glasgow, Glasgow G12 8QQ. Tel 041-339 8855 Ext 5226.



UNIVERSITY OF READING/ICI SEEDS



Seeds

CASE STUDENTSHIP IN THE MOLECULAR BIOLOGY OF PLANT REPRODUCTION

Applications are invited from suitably qualified graduates for an SERC CASE Studentship in collaboration with ICI Seeds. The work will involve the study of gene expression during pollen development in crop plants, using *in situ* hybridisation with developmentally-specific probes. The successful candidate will join a team at Reading working on molecular aspects of plant gametogenesis, but will also spend extended periods working in the laboratories of ICI Seeds at Jealotts Hill.

Applicants should have, or hope to gain a good Honours Degree in biochemistry or relevant biological science. All applications, together with a full cv and the names of two referees should be sent to Professor Hugh Dickinson, School of Plant Sciences, University of Reading, Whiteknights, PO Box 221, Reading RG6 2AS, from whom further information is also available.

UNIVERSITY OF SOUTHAMPTON

Department of Biology

PhD STUDENTSHIPS

Applications are invited for the following studentships to begin in October, 1988. Candidates should have or expect to obtain a first or upper second-class degree in an appropriate area of the biological sciences or biochemistry.

1. University Studentship on the biochemistry of membrane transport and secretion in higher plants.
2. SERC-CASE Studentships on the following topics:
 - a) Functioning of the host/parasite interface in haustoria of powdery mildew (with ICI Plant Protection Division)
 - b) Effect of air pollutants on membrane transport function (with Central Electricity Research Laboratories)
 - c) Sucrose transport mechanisms in tomato fruit (with Institute of Horticultural Research)

Projects a) and b) have an additional allowance above the normal maintenance grant.

Send enquiries and applications as soon as possible to Prof J. L. Hall, Department of Biology, Building 44, The University, Southampton SO9 5NH. Tel (0703) 559122.

BRISTOL POLYTECHNIC
SERC RESEARCH
STUDENTSHIP
BIOLOGICAL SCIENCES

Applications are invited for a SERC studentship tenable from 1 October for ONE of the following projects:

Plant Cell Culture

- a Advanced systems for plant regeneration—Dr C. S. Hunter
- b Glycyrrhizin production by liquorice hairy root cultures—Dr S. J. Neill

Plant pathology

- c Characterisation of the parasitic interface in downy mildew infections of pea—Dr P. Spencer-Phillips

Immunology

- d Interleukin 2 regulation in cancer patients—Dr L. S. English

Biochemistry/Molecular Biology

- e The role of the Nucleotide-binding Domains of Aspartate Transcarbamoylase in *Acinetobacter calcoaceticus*—Dr M. Shepherdson

Applicants must have or expect to obtain a 1st or upper 2nd class honours degree in appropriate biological subjects. Applicants should contact Dr Alen Vivian in the first instance for further information regarding further particulars of each of the above projects: Tel Bristol (0272) 656281, Ext 2470. Alternatively letters of application together with a cv should be returned as soon as possible to: Dr A. Vivian, Molecular Genetics Lab, Science Department, Bristol Polytechnic, Coldharbour Lane, Frenchay, Bristol BS16 1QY.

MRC CLINICAL RESEARCH CENTRE

(Northwick Park Hospital)
Watford Road, Harrow
Middlesex HA1 3UJ



PhD STUDENTSHIP IN MOLECULAR ENDOCRINOLOGY

Applications are invited for a MRC Research Studentship in the Endocrinology Research Group of the Clinical Research Centre. The student will form part of a team analysing the regulation of the gonadotrophin hormone glands using whole animal transgenic animal and cell culture approaches. It is envisaged that the student will identify regulatory sequences and proteins for these genes and begin to explain in molecular terms the physiological regulation of the gonadotrophins. Candidates should have or expect to obtain a First Class or Upper Second Class Honours degree in an appropriate subject.

Further information may be obtained from Dr J. Powell or Dr R. Clayton on 01-864 5311, Ext 2466 or 2527.

Application forms are available from the Personnel Section Ext 2673 quoting Ref MRS/RS/NS. Closing date for completed applications is 21 July, 1988.

The Medical Research Council is an Equal Opportunity Employer.

University of York

D Phil in Nuclear Physics

A vacancy exists for a graduate who has a first or upper second class honours degree in physics to study for a D Phil in experimental nuclear physics. A standard SERC postgraduate studentship is available for three years for this position.

The experimental programme will primarily be carried out using the 20 million volt tandem accelerator at the SERC Daresbury Laboratory in Cheshire.

The current major research interests of the nuclear physics group are in (a) studying the behaviour and highly deformed shapes of nuclei rotating at very high angular velocity (b) studies of nuclei with exotic proton/neutron ratios and (c) the study of novel modes of nuclear break-up in light nuclei.

Interested persons should write, or telephone, as soon as possible for further information to either: Dr D. L. Watson or Dr R. Wadsforth, Dept of Physics, University of York, York YO1 5DD. Tel 0904 430000, Ext 5580 or 5579.

Go East, young scientist

FEW British scientists will have paid any attention to the summit meeting of the world's leaders in Toronto last week. That is understandable. The main subjects on the agenda, subsidies to farmers and Third World debt, have an intractable air which seems to defy rational thought. Even the old game of naming who's in the photographic lineup is losing its appeal: "There's Maggie and Ron, of course, and Mitterrand and Kohl and what's his name, the Canadian. Lost track of Italian politics years ago. And the Japanese chap on the end... took over from Nakasone didn't he?"

In fact, one of the summit's more solid achievements was the signing by Noboru Takeshito, Prime Minister of Japan, and President Ronald Reagan of a new five-year pact to collaborate more closely in science and technology. The signature, like most summits, was largely symbolic. Ministers and their civil servants sorted out the details two months ago.

Briefly, amid much talk about increasing cooperation in biotechnology, information science and new materials, including superconductors, the agreement resolves some sticky disputes over intellectual property rights and patents.

Cynics will say that Reagan and Takashito put on their show because, beset with trade disputes, scientific cooperation was one of the few fields in which they see eye to eye. But this interpretation does no justice to the importance Japan and the US give to the flow of technical information between their countries.

Japan has a reputation of being a scientific taker rather than an innovator. This is largely justified, although it is more accurate to substitute for "taker" the word "buyer at fair market prices". The Japanese are more sensitive than anyone to the fact that their researchers can create personal stereotypes or four-megabit memory chips, but hardly ever win Nobel prizes. They are determined to change this image.

The desire to "put something back into the system" is not simply altruistic. Another incentive is the survival of the Japanese economy. Famously short of raw materials and surrounded by energetic economies that can turn out ships, cars and even personal computers at a fraction of the cost of their own factories, Japan knows it has no long-term future in the metal-bashing industry. Survival means innovating.

The consequence is an unprecedented opening of Japanese government, academic and private laboratories to foreign scientists. Some initiatives, such as the Human Frontiers Science Programme, which like many grandiose schemes seems in danger of becoming bogged down in its own importance, make headlines. Others, by individual companies, research institutes and scientists themselves, are far more important.

Earlier this month, Britain's trade minister, Alan Clark, told industrialists: "In Japan over the past year, fundamental steps have been taken by government agencies... to 'internationalise' the science and technology base of Japan." Japanese

companies pay for 80 per cent of all the country's science. And according to a survey published last week, the research spending of the major companies will rise by 22 per cent this year.

British scientists have so far fared comparatively well in the new opening of Japan, but too few of them are working there. In 1986, 1124 British researchers were working in Japan. This was three times as large as the contingent from West Germany, a country which Japanese opinion polls normally rank ahead of Britain in scientific achievement, but far fewer than the 4367 Japanese researchers (including students) in Britain.

British researchers in Japan face two main problems; the language and the cost of living. Given the inability of the British educational system to turn out scientists and engineers passable in French and German, the language barrier seems likely to remain. But British universities could usefully duplicate the Japan programme of the Massachusetts Institute of Technology which prepares science students for a stay in Japan.

It should be easier to provide financial support for researchers visiting a country where a carrot costs £1 and a melon up to £70. The government should lean on its corporate friends—in particular the cash-rich Japanese companies—to set up a fund for deserving cases.

Prejudice to Japan being what it is, people will always ask what Europe will gain in exchange for this trade in scientists. Not a few will point to Japan's history of exploiting other people's inventions and demand barriers to stem the flow of scientific information to Japan. The simple answer is that research always gains from exchange. Any community that shuts itself off will end up intellectually poorer.

There is a selfish reason, too. The world's economic focus is shifting from the Atlantic to the Pacific basin. This trend will surely accelerate if Japanese investment in future technologies such as superconductors and optoelectronics pays off. Unless Europe works hard now to forge links with the pacesetters in these new fields, it could find itself an economic and cultural backwater in the next century.

Britain's position is particularly precarious. The country has hosted more than its share of the first round of investment by Japanese companies. But recent announcements suggest that Japanese companies do not see Britain as the right place for the second wave, which will put design and development into European hands. For example, Toyota, the car giant, is building its European design centre in Brussels. And last week Sony chose to put its new development centre not in Britain, the site of the company's largest factory in Europe, but in West Germany. The issue of Japanese investment in Britain opens a whole new can of worms. But what is clear is that the new opening of Japan gives British science and technology a chance to form productive new links with a new force on the world stage. Both sides recognise that they have a lot to learn, which is always a good starting point for cooperation. □

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THIS WEEK

Greenhouse warming grips American corn belt

Ian Anderson, San Francisco

The drought has lasted for three months. Conditions are the worst since the famous "dust bowl" drought that lasted from 1934 to 1936.

SCIENTISTS at NASA sparked a controversy among climatologists last week by declaring that the drought now devastating much of the American Midwest and the prairies of Canada may be an early manifestation of the greenhouse effect. Global temperatures so far this year are the highest on record, continuing a strong warming trend through the 1980s.

"It is time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here," said James Hansen, the top climate modeller at NASA's Goddard Institute for Space Studies in New York.

Other scientists said last week that both the drought in the US and the recent rise in global temperatures could be explained by natural fluctuations.

According to the greenhouse hypothesis, a buildup of pollutants in the atmosphere will cause the Earth to warm up. Some gases, particularly carbon dioxide from burning fossil fuels, allow sunlight to reach the Earth's surface but do not allow the heat to radiate back into space. Some models predict that average temperatures will increase by as much as 6 °C during the next century, with areas near the poles warming by as much as 12 °C.

Last week, Hansen said: "It is not possible to blame a specific heatwave or drought on the greenhouse effect." But, according to climate models developed at Goddard, the greenhouse effect is now large enough to make such events much more likely. Droughts and heatwaves will increase in the American midwest and southeast over the next decade, the scientists said.



Echoes of droughts in the 1930s. Is the greenhouse to blame?

Last week, Hansen testified before the Senate Energy and Natural Resources Committee in Washington. He said that, unless there was "remarkable and improbable cooling" in the remainder of the year, 1988 would be the warmest year on record worldwide, beating last year's record. The first five months were warmer globally than any comparable period since measurements began 130 years ago.

The four warmest years in the past century—1980, 1981, 1983 and 1987—have all occurred this decade. Temperatures this decade have been 0.4 °C higher than the average for the period between 1951 and 1980. "The probability of this being a chance warming is about 1 per cent," says Hansen.

But others are not convinced. Stan Changnon, a meteorologist at the Illinois State Water Survey, said that the greenhouse effect could not explain the cool, wet periods that existed in the Midwest for about 40 years up until two years ago.

"Ten years ago we had the worst winters in 200 years," he said. "My 50 years of scientific training and intuition would say that this drought is part of a pattern of extreme climatic variability."

Data derived from tree rings show extreme droughts in the past, lasting for as long as 30 years (see p 45).

Hansen was accused of doing a disservice to science by declaring that the greenhouse effect had arrived. Michael Schlesinger, from the Climatic Research Institute at Oregon State University at Corvallis said: "We can lose our scientific credibility if we say things too strongly too early. If you look back to 1940, following the drought of the 1930s, people were making similar statements to what Jim is saying now, but we ended up having 35 years of cooling. We cannot afford to cry wolf again."

Schlesinger and Jim Barnett, from the Climate Research Group at Scripps Institution of Oceanography in La Jolla, Cali-

fornia, say that Hansen's models lack information about what is happening to temperatures and climate at sea. El Niño, a warming of the Pacific Ocean that occurred in 1982-83 and 1986-87, could well have raised global temperatures. But this phenomenon is not included in the model. Other scientists have suggested there could be a link between El Niño and the amounts of carbon dioxide in the atmosphere (*New Scientist*, 17 March, p 29).

Syukuro Manabe, from the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration (NOAA), said: "The drought is too severe to blame it all on the greenhouse gases." But the severity of the summer dryness in the middle of the continent will increase as higher atmospheric temperatures cause the snows to melt earlier and the rain belt to move further north in summer.

The greenhouse effect could be slowed, scientists told the Senate committee, if controls restrain emissions of greenhouse gases. Besides carbon dioxide, these include methane from agricultural sources and rubbish dumps, and nitrous oxides from car exhausts and fertilisers. Meteorologists said last week that the immediate cause of the drought was an area of high pressure that had remained over the central US for several months. The jet stream, a fast westerly airstream that follows a path through the upper atmosphere at mid latitudes, pulling rain-bearing depressions with it, was farther north than normal.

The stable, warm air now over the Midwest may be broken up by hurricanes moving north from the tropics. But the hurricane season has just begun.

The drought extends from Ohio to Montana. The Canadian prairie states of Alberta, Manitoba and Saskatchewan are also affected. Last week, the US Agriculture Department listed 1455 counties—almost half the total in the US—as suffering from drought.

Unless substantial rains fall in the next few days, the American corn crop will be ruined. Early July, when the kernels normally appear, is a critical period in the growing season. At least one fifth of the corn crop has probably been lost already.

Crops of wheat, barley, oats and soya beans are also threatened. Farms are sending cattle to market because of the lack of feed, so meat prices are low.

Hundreds of barges are grounded in rivers because water levels are low. Some 1800 barges have piled up on the Mississippi River waiting for dredgers to cut channels. The lack of water in streams and rivers is also concentrating agricultural and industrial wastes and treated sewage. Warmer water contains less dissolved oxygen which can also kill fish. □

OBSERVER David Austin

WE TOLD HIM HE COULD STOP THE ICE CAPS MELTING.



Crash fuels worries about computers aboard Airbus

Helen Gavaghan and Susan Watts

PILOT error rather than computer failure is being blamed for last Sunday's crash of an A320 European Airbus, which killed three people. The French civil aviation authority says that, at this stage in its investigation, the aircraft does not appear to be at fault.

British Airways and Air France, which both withdrew their A320s from service after the crash, returned them to service on Tuesday. Britain's Civil Aviation Authority says it knows of no reason to suspect a computer malfunction.

Not everyone connected with the industry accepts this. William Tench, formerly an investigator with the Department of Transport's Air Accident Investigation Branch, says that, rather than issuing bland statements, the CAA must explain this conclusion.

The International Federation of Airline Pilots' Associations says: "If they are prepared to put that statement out, they must be more positive and say what they found out." A spokesman for the association said that snap judgements made in the past have later proved wrong.

The French authorities have an unusually large amount of information available to help their investigation. Both the flight-data and voice recorders were recovered immediately, both pilot and co-pilot are alive, and television cameras and microphones recorded the whole event.

These data will resolve whether the A320 crashed because of failings in the aircraft's controversial new "fly-by-wire" technology. The technology effectively allows computers to act as a clearing house for instructions from the pilot. The computers are programmed to prevent the pilot directing the plane to operate beyond its technical capability.

The plane crashed after failing to gain height after making a low "pass" over the runway during an airshow at Habsheim airport in France.

The idea that the computers were to blame arose because the pilot reportedly



A tale of woe. Was the pilot or the computer to blame?

told rescue workers that the engines would not respond when he tried to lift clear of trees at the end of the pass. There was speculation that the computer had blocked the pilot's instructions.

If the pilot had stayed well clear of the ground, the computer would automatically have controlled the manoeuvre. On Sunday, however, the plane flew at a height of a few tens of metres. At this height the computer believes that the plane is landing, and to gain height the pilot must open the throttles manually.

Tench thinks it is possible that the pilot may have been confused about whether or not, in that situation, he was flying automatically or manually. He may have opened the throttle too late to avoid hitting trees at the end of the runway.

The A320 is the first civilian fly-by-wire plane (*New Scientist*, 2 April 1987, p 38). Whether or not the computers caused this accident, some scientists question whether the computer software in fly-by-wire technology can do the job.

Mike Hennell, professor of computational mathematics at Liverpool University, says: "We can't construct an adequate set of rules for writing such complex software. Much simpler software, such as for anti-skid brakes on cars, has not been successful."

The software and hardware on the A320 are designed to minimise the risk that one fault could cause the system to fail. There are five computers and two back-ups. Each of the five has a primary task and a secondary task. If one computer fails with its primary task, that task is allotted to another computer as a secondary task. The microprocessors within each computer come from different manufacturers so that a fabrication fault will not be common to all the chips. And software is written by different teams and installed so that the programmes cross check.

● Martin Thomas, the head of the policy committee of the British Computer Society, is looking at the development of computerised safety systems. "It is very difficult to get enough information to decide whether the A320 flight control system is adequately safe or not," he said this week. "We need to know what techniques they have used for verifying the software. The 10⁻⁹ figure of failure rate that Airbus is quoting cannot be substantiated. The only way they could get that figure would be to do 10⁹ years worth of testing."

Thomas says that the kind of probability calculation done by Airbus "either plucks a figure out of the air to represent the failure rate of their verification method, or ignores completely things which are difficult to quantify, such as human error."

"I would like to think that they used formal methodologies in the development of the software, but I am not aware that they have gone down that line. I would know if they had," said Thomas.

These formal methodologies allow software developers to check, and then prove, that their software meets its specifications. They do not check whether the original specification was right.

Thomas says: "I would like to see Airbus Industrie either publish the full details of the way the systems were developed, for peer review, or make this available to a body such as the British Computer Society, in confidence. I would also like to see all faults in safety critical systems registered, on a worldwide basis, to get hard facts and form sensible opinion of the reliability of such systems." This, he points out, is what happens with the rest of the plane. "Any accident has to be reported, if it's good enough for the planes, why can't the same be done for the software." □

MPs quiz government on DNA fingerprinting test

THE GOVERNMENT came under pressure this week to clarify its position on taking mouth swabs forcibly for genetic fingerprinting of terrorist suspects in Northern Ireland. Kevin McNamara, Labour's spokesman on Northern Ireland, has written to Tom King, the Secretary of State for Northern Ireland, asking him whether the police intend to scrape the inside of the mouth for cells, rather than take samples of saliva with a swab.

McNamara quotes an article in last week's *New Scientist* (p 27) which, he tells King, "suggests that such swabs would not usually be a particularly reliable means of obtaining sufficient DNA material for DNA profiling". This, McNamara says, conflicts with the statement made in the House of Commons by John Stanley, a junior minister for Northern Ireland, when justifying the introduction of the technique.

"I further understand that sufficient material for DNA purposes could be obtained, not by a mouth swab, but by scraping the inside of the mouth with a

blunt instrument," McNamara writes. "If this is the case, it would suggest that you have been wrongly advised on this matter."

The Northern Ireland Office seems to have based its plan on a paper written by government scientists and published last year in the journal *Electrophoresis*. The paper describes genetic fingerprinting using "buccal swabs". The swabs were scraped against the inside of the cheek, rather than being used to collect saliva.

Stanley told the House of Commons two weeks ago that the government wants to take "a sample of saliva" with a mouth swab "which can be taken by rubbing the area between the lip and the gum, without any need for the mouth, other than the lips, to be opened".

McNamara believes that Stanley has misinformed the House of Commons. The issue, he says, "raises serious questions about the quality of scientific evidence given to the Secretary of State and about whether or not the House was given accurate information on this matter". □

Dust-up over legionnaire's disease

AIRBORNE debris from building sites could be an important and so far underrated cause of legionnaire's disease, according to Christopher Bartlett, a top epidemiologist at the British government's Communicable Diseases Surveillance Centre.

His warning, made in an interview with *New Scientist*, came after last month's outbreak of the disease at the BBC's Broadcasting House in central London, in which two people died. Bartlett's suspicions have prompted the Department of Health and Social Security to issue tough new guidelines for hospital engineers next month.

The new guidelines will require weekly inspections of water tanks in air conditioning systems at hospitals. Until now, the rules have required "regular" inspections.

Warm water in the cooling towers of air conditioning systems provides ideal conditions for Legionella bacteria to grow and spread, according to a report in 1986 on Britain's worst outbreak, when 28 people died after visiting Stafford hospital.

Many cooling towers use sprays of water to dissipate the heat removed from air by chillers. In the Stafford outbreak, an air inlet to the hospital's air-conditioning sucked spray containing the bacteria into the building. The contaminated fine droplets can be breathed deep into the lungs.

Bartlett points out that the fans in cooling towers also act as "giant vacuum cleaners, sucking in dust from all around". The dust may neutralise common sterilising agents put into cooling towers to kill bac-

teria, and provide a ready source of the food that bacteria need to multiply rapidly.

Building works are a frequent source of large volumes of dust, and Bartlett said that engineers should make frequent checks of cooling towers whenever there is a building site nearby.

Patrick O'Sullivan, a specialist on building hazards from the Welsh School of Architecture, claims there were building sites near 90 per cent of the outbreaks of legionnaire's disease that have been traced to cooling towers. He told an internal inquiry at the BBC into the outbreak at Broadcasting House that he was "concerned at the high level of building works in the vicinity". He said that builders should be required to notify tenants of nearby buildings of the potential hazards of dust from their sites.

Linda Allen of the Institute of Environmental Health Officers questions this idea. She says that, in cities such as London, "everyone is near a building site". A spokesman for the government's Health and Safety Executive said this week that the link to building works is "a bit far-fetched" and that, so long as there are regular inspections of tanks, there should be no risk.

The HSE is writing its own report on the BBC's outbreak. The spokesman said that, at the moment, the executive does not intend to modify its guidance notes on the disease, which were issued in January 1987. These make no mention of the dangers from building works and do not require weekly inspections.

AIDS and the poor

A STUDY of patients tested for the AIDS virus as they checked into an emergency room in a hospital in Baltimore, Maryland, reveals an alarmingly high rate of infection among poor Americans.

Researchers at the Johns Hopkins University Hospital screened 2302 adults during a six-week period this year. They found that 119 (5.2 per cent) were infected with the human immunodeficiency virus (HIV) which causes AIDS.

The number of people who did not know that they were infected—92 people, or 4 per cent of all admissions—surprised the researchers, led by Gabor Kelen. He writes in last week's *New England Journal of Medicine* that accident patients aged between 25 and 34 from the hospital's urban neighbourhood, a run down inner-city region, are seven times more likely to be infected than the country's general population.

The researchers say that health care workers who staff emergency units deserve extra protection because they often have to treat people immediately and so have no time to find out whether patients are carriers of the virus.

Pain in head

ACUTE attacks of severe migraine may in future be treated with a new drug that mimics, instead of blocking, the effect of a chemical called 5-hydroxytryptamine (5-HT), which occurs naturally in the body. German physicians collaborating with researchers at Glaxo reported this week that the drug, codenamed GR43175, was effective when given intravenously, in 17 of 24 severe attacks, and probably works by closing blood vessels in the head.

Foot in mouth

BRITAIN is to lose its only laboratory for handling animal viruses that might enter the country after trade barriers with the rest of the EEC fall in 1992. The Agricultural and Food Research Council announced last week that the Animal Virus Research Institute in Pirbright, Surrey, is to merge with the Poultry Research Station near Cambridge, the Neuropathogenesis Unit near Edinburgh and the Compton Laboratory. They will all move to the Compton site, near Newbury, under the umbrella title of the Institute for Research into Animal Diseases.

Staff from Pirbright say the move is "myopic in the extreme". Theirs is the only institute in Britain allowed to work on "exotic" viruses such as African swine fever, which is endemic in Spain, and foot-and-mouth disease, which is common in Italy. Both countries will be able to export meat to Britain after 1992. The Pirbright staff argue that, however good border controls on meat may be, this is a bad moment for Britain to lose its ability to handle the viruses.

Bermuda Triangle explained

A SOVIET science magazine has proposed an explanation for the supposed mystery of the Bermuda Triangle, where ships are said to go missing. The magazine, *Priroda*, blames the losses on discharges of methane and other gases from the sea bed. It says that Soviet researchers have found that layers of gas-hydrate, a solid compound of methane and water, are present in the upper layers of sediments in deep troughs such as the Bermuda trough. At low temperatures and high pressures, the gas-hydrate forms a solid shell up to 300 metres thick beneath which considerable volumes of gas can build up.

If cracks form in the shell, the gas bubbles to the surface of the ocean. In one observed case on the Sea of Okhotsk, the vented gas formed a 500-metre "plume" of methane, carbon dioxide and hydrogen sulphide in the air. If a crack released a lot of gas in one go, says *Priroda*, the crew of any ship or low-flying aircraft in the vicinity would suddenly be deprived of oxygen. That, says *Priroda*, could be "catastrophic".

Electronic linesman stays on the sidelines

A CANADIAN company has developed a new electronic system for calling line faults in tennis matches. An artificial voice and a system of coloured lights tells players, umpire and audience if the ball was out.

Accu-Call is on trial in Portland in Oregon, and in Toronto, where John McEnroe tested it in February. Its inventor, John Van Auken, an American based in Nova Scotia, Canada, said McEnroe's only complaint was that it came ten years too late.

The system consists of a mesh of fine wires hidden along the lines in the court's surface, and tennis balls with conductive fibres in their covering. When the ball lands outside the line or hits the net it completes a circuit which is detected by a computer. A system suitable for major tournaments costs up to \$150 per match to rent. Accu-Call is in use on hard acrylic surfaces and the manufacturer, Canadian Tennis Technology, has now adapted it for clay courts.

But Wimbledon is unlikely to swap it for its present Cyclops system, which uses infrared beams, because the electronic



McEnroe last week: The call came ten years too late

system is unsuitable for grass courts. The chief of umpires at Wimbledon, Roger Smith, is satisfied with the Cyclops system, invented by Bill Carlton and used in all the international tournaments.

Hospital incinerators stoke up pollution row

Roger Milne

BRITAIN'S pollution inspectors last week criticised health authorities for "deplorable" standards at hospital incinerators that burn dangerous clinical waste, including soiled dressing, drugs and flesh. The government's Hazardous Waste Inspectorate described spot checks at 15 hospital incinerators in its annual report. It said: "If the small number of hospitals visited are typical of the national picture, then the situation is deplorable."

Waste inspectors have no legal powers over hospitals, which have "Crown immunity", but the report says that the hospitals visited "operate to standards which would not be permitted in the private sector".

Incineration of dangerous clinical waste requires sustained high temperatures in the combustion chamber and afterburner, where temperatures should reach at least 800°C. The inspectors found "totally inadequate temperature monitoring". Sometimes there were no temperature gauges; sometimes they were in the wrong place. It was usually impossible to say how efficiently waste was burned.

In several incinerators "afterburners were not operational and had, in some cases, been removed altogether. . . . In a number of instances, the height of the stack was less than that of nearby hospital buildings".

The inspectors' report paints a damning picture of the standard of British waste management. "The contrast between the best and the worst remains as dramatic as ever," it says. It also criticises the role of waste "brokers" and importers.

One case study illustrates the problems. It concerns 60 000 tonnes of gypsum waste, some contaminated with cyanide, from a citric acid factory in Germany. The waste began its travels by crossing the border to the Netherlands, where it was erroneously

labelled as "aggregates". The Dutch government fined both the producer and the importer of the waste.

European waste brokers then all bid for the waste, half of which was shipped to Britain where a major British waste firm buried it in a landfill dump. The remainder, contaminated with cyanide, disappeared. After an investigation by Customs and Interpol, it turned up in the hands of a British dredging company which, without knowing what the material was, intended to dump it to fill a hole in a marine reclamation project. The waste was eventually dumped illegally on an island in a former naval dockyard.

The low cost of waste disposal in Britain is opening the floodgates to waste imports, says the report. Metal hydroxide filter cake costs between £15 and £25 per tonne to dump in France or West Germany. In England the job costs £5 per tonne.

Arrangements for dealing with toxic wastes in big cities have deteriorated since the abolition in 1986 of the metropolitan county councils and their well-staffed technical departments, say the inspectors. They are particularly "disturbed" by slipshod standards in the West Midlands, which in

1986 handled a fifth of England's hazardous wastes.

The Hazardous Waste Inspectorate comprises five inspectors with no statutory powers (those reside with local authorities) and 5000 tips, incinerators and waste transfer stations to keep an eye on. David Mills, the chief inspector, says that, despite past promises, his report cannot "name names" because his staff do not have the time to solve the legal problems.

The report reveals that Britain is ill-equipped to handle large volumes of reject aerosol cans. A fire at a specialist waste firm that drains chemicals from the pressurised cans means that the country now has only one company in the field—and that has a backlog of five years.

The problem came to light when a pharmaceuticals company produced 1.5 million faulty aerosols containing a prescription drug and chlorofluorocarbons as propellant. The inspectors oppose putting aerosols into landfill dumps because of the risk that the cans will corrode and their contents will pour into groundwaters beneath the tip. In the event, the aerosols were dumped in landfills in small quantities under careful supervision. Last year, Britain produced more than 800 million aerosol cans. □

Plan to clean up Nigerian dump

A TEAM of British scientists and environmental campaigners who returned last weekend from Nigeria has recommended prompt but cautious action to clean up a dump of toxic wastes at Koko, a port on the river Niger (*New Scientist*, 23 June, p. 30).

Scientists from the UK Atomic Energy Authority at Harwell have already filed a report, commissioned by the British Overseas Development Administration, with

the Nigerian government. The team brought back samples of the waste for analysis. It found toxic industrial wastes, but no radioactive materials.

The Nigerian government invited Friends from a Earth to visit the dump. Mark Line, from a British waste management consultancy Aspinwall, said that the dump contains about 10 000 drums, each containing 225 litres of waste. Line said he had opened nine drums and three shipping containers, each holding about 70 drums.

He found highly flammable solvent wastes in sealed containers unshaded from temperatures reaching more than 40°C. He also believes there were large amounts of polychlorinated biphenyls (PCBs), carcinogens known to accumulate in the bodies of animals. Line was puzzled about why European companies should take PCBs so far, when some capacity to incinerate them exists in Europe.

He said the principal risk to the dump is fire, because Koko's population of 800 to 1200 could inhale "potentially very toxic" materials from the smoke.

The dump, which is open and unprotected, consists largely of five shipments of Italian waste which arrived between August 1987 and May 1988.

Friends of the Earth recommends a programme to guard the waste and move people away from the immediate vicinity. Line stressed the drums should not be moved in their present state or without qualified supervision.

This week, Italy announced that the unnamed Italian firm which produced the waste would take it back, provided the Nigerians released the crew of the Italian freighter, Piave, impounded after the waste was found. Italy will also take back waste found in Lebanon. □

More rock-solid evidence of Archaeopteryx

A NEW fossil specimen of *Archaeopteryx* has been discovered in the collection of an amateur geologist. *Archaeopteryx* is an important fossil because it combines features of reptiles and birds. This new find brings the total number known to six. It also provides further evidence to challenge claims that the *Archaeopteryx* did not exist.

Peter Wellnhofer, a curator at the Bavarian State Collection of Palaeontology and Historical Geology in Munich, says that the new fossil is the largest of all, 10-per-cent bigger than the London specimen. In other respects, it is almost identical. The skeleton is extremely well preserved and there is a hint that it may have a furcula, or wishbone, a feature missing from other specimens.

The amateur who owned it did not know exactly where the fossil originated. Nor did he realise it was *Archaeopteryx*, mistaking it for a small dinosaur called *Compsognathus*.

The new fossil has "distinct parallel impressions" originating at the left forearm. These are the shafts of feathers, Wellnhofer says. "A question of forgery does not arise." □



Half bird, half reptile

Peter Wellnhofer/Science

Pharmaceuticals giants battle over clot-busting drug

Steve Connor and Ian Anderson

THE LEGAL wrangles over tissue plasminogen activator, a natural protein that can dissolve blood clots, continued this week on both sides of the Atlantic.

The dispute is between Genentech of California and Wellcome of Britain. Both lay claim to rights over the manufacture of TPA by genetic engineering. Last week, Genentech won an American patent on the drug, and immediately tried to stop Wellcome testing and marketing its version of TPA in the US.

In the Court of Appeal this week in London, Genentech continued to dispute a decision last year by a British court that its patent was invalid (*New Scientist*, 16 July 1987, p 25). Again, Wellcome is the company that decided to contest Genentech's rights over the drug.

Meanwhile, the University of Oxford and Monsanto, an American chemicals company, have also won a patent in the US on TPA (*New Scientist*, 9 June, p 35). This patent could affect the rights of both Genentech and Wellcome. A spokesman for Wellcome said that the company is trying to obtain a copy of Oxford's patent "to study it in detail".

Genentech sells its TPA in the US under the tradename Activase. The company

hopes to have sales this year of \$250 million. Doctors use the drug to dissolve blood clots that can cause heart attacks.

Researchers at the University of Leuven in Belgium first purified TPA in 1979, and gave commercial rights over the drug to a Belgian company called Innovo. Innovo has a licensing deal with Genentech whereby the American company has exclusive rights to market TPA in the US.

After the American court awarded the patent rights to Genentech and Innovo, the two companies immediately sued Wellcome and its American partner, the Genetics Institute of Massachusetts. The Genetics Institute has developed a strain of TPA that Wellcome manufactures.

Genentech wants an injunction issued against Wellcome, which would stop the British company from continuing to work on TPA in the US. A spokeswoman for Genentech said that if the courts grant the injunction it would force Wellcome to halt clinical trials of the drug.

At the same time that Genentech and Wellcome are battling it out in the British and American courts, they are fighting on a third front—in the European court, which resolves issues in the European Patent

Office. If either company wants to appeal against this court's decision they have to do so in each country affected by the verdict.

Wellcome appears to be losing the fight in Europe. The European Patent Office has issued a patent on TPA, similar to the American patent, to Innovo and Desire Collen of the University of Leuven, which first purified TPA. A spokesman for Wellcome, however, said that it is not yet clear whether the European court will give Genentech and Innovo all that the two companies are asking for.

In London this week, the Court of Appeal listened to Genentech's case for the court overturning a decision last year to make Genentech's patent on TPA invalid. The judge in the earlier case, Mr Justice Whitford, found that the techniques and processes that Genentech used to make TPA did not fulfil the criteria of novelty and inventiveness required by law.

If Genentech loses its fight in the Court of Appeal, it says that it intends to take the battle to the House of Lords. □

Blooming confusion

POLLUTION may not have caused the bloom of algae that killed thousands of fish in Norwegian fish farms last month (*New Scientist*, 16 June, p 36).

Scientists first suspected that nitrogen, which was at twice its usual concentration in the North Sea this spring, made the algae grow faster. But scientists meeting at the Kristineberg marine station in Sweden last week reported that cells of the algae, *Cryptochromulina polyplepsis*, did not divide faster than usual. "If that is confirmed, it was not nutrients that triggered the bloom," said Odd Lindahl of Kristineberg.

High levels of nitrogen, while not the cause, could have been necessary for the bloom to have grown so big. Scientists reported, however, that the algae took up very little of the nitrogen available.

Another theory is that cobalt or another metal washed from soils by acid rain could be to blame (last issue, p 27).

At a separate conference on the bloom, held last week in Bonn, Chris Reid of the Plymouth Marine Laboratory in Britain said there is no evidence that more blooms occur now than in the past, despite increases in pollution from nutrients such as nitrogen.

He says that blooms are a normal feature of the North Sea and that this particular bloom might have gone unnoticed had it not killed fish that were valuable commercially.

The algae may have bloomed because organisms that normally eat them were present in unusually low numbers as the bloom evolved. This in turn may have been because the algae were producing a potent toxin that killed a wide range of organisms, including fish.

Michael von Websky of West Germany's environment ministry said in a communique issued after the Bonn meeting that "the scope, frequency and seriousness of algal blooms has significantly increased in the past 25 years. It can be supposed that a high level of nutrients in coastal waters" has contributed to this. □

Germany to cut nutrient pollution of North Sea

WEST Germany's environment ministry has announced a set of measures to curb pollution reaching the North Sea from German rivers.

Two key measures aim to reduce pollution by wastes containing nitrogen and phosphorus. In towns of more than 5000 inhabitants, waste disposal authorities must, by 1989, limit to 10 milligrams per litre the discharges of nitrogenous wastes from sewage treatment plants. The Germans had planned to achieve these levels by 1992.

Another plan, also brought forward by three years, is to reduce discharges of phosphorus waste from sewage works to 1 milligram per litre in towns of more than 100 000 people. Nitrogen and phosphorus may upset marine ecology by stimulating the growth of algae.

From 1991, companies will have to pay levies according to the amount of nitrogen and phosphorus they discharge. By mid-1989, stricter laws will limit discharges of heavy metals, ammonia, hydrocarbons and other toxins. After 1989, companies must recycle dilute acidic waste instead of dumping it in the sea.

More immediately, the West Germans have limited incineration of waste at sea to 55 000 tonnes this year. In 1991, the limit will have fallen to 20 000 tonnes. By 1994,



North Sea bathing: a shame that the seals are dying

the practice will be banned completely.

The ministry also plans to spend DM10 million (£3 million) paying farmers not to put fertiliser on strips of river bank 100 metres wide, so protecting 10 000 square kilometres of bank throughout the country. Most of the nitrogen pollution in the North Sea is thought to originate from agricultural fertilisers.

The ministry has earmarked DM12 million for ecological research in the North Sea over the next few years, and DM4 million for similar work in the Wadden Sea, where a mysterious epidemic has killed 860 seals in Danish and Dutch waters.

West Germany wants an international commission to control pollution in the River Elbe which passes through Czechoslovakia and East and West Germany, and accounts for 15 per cent of the nitrogen in the North Sea. □

THIS WEEK

NASA's studies of space biology 'lack weight'

Christopher Joyce, Washington DC

protests about the Soviet invasion of Afghanistan halted cooperation between space scientists from the two countries.

Last year, communications resumed as



Fun at first. But weightlessness can be dangerous

the USSR and the US renewed a joint agreement. But the Americans have not yet evaluated such feats as the 326-day orbit of cosmonaut Yuri Romanenko, says Nicogossian.

According to Francis Moore of Harvard University, who is also on the committee, Romanenko lost a lot of calcium and nitro-

gen on a previous lengthy flight. Adjusting to Earth's gravity was so exhausting that Romanenko "could barely sit up in bed," says Moore.

During his latest orbit, which set a record for uninterrupted periods in space, the cosmonaut was "psychologically conditioned" to recognise the onset of physical disability. He exercised for four hours each day while in orbit. Soviet scientists have yet to discuss with NASA the details of Romanenko's adaptation to Earth's gravity.

Officials of the space agency say they plan a "space biology initiative" to promote the status of life sciences within NASA. One project involves carrying a large centrifuge on the space station, which would subject astronauts to various simulated gravitational forces.

Robbins's committee recommends a wide variety of other projects, including satellites to test the effects of radiation on life forms, better monitoring of conditions in spacecraft and more cooperation with the Soviet Union. NASA should also establish professorships in space medicine at universities, the panel says.

Of special importance are new ways to monitor the health of astronauts aboard space capsules. "You wouldn't want to spend six months with a rectal thermometer," observed William Schneider, a member of the advisory panel. Schneider also said that NASA needs to find out how to detect and eliminate trace gases and other wastes that would build up in a space vehicle over long periods.

NASA is battling with Congress this week to win an increase in its budget. The cost of the space station, which NASA puts at nearly \$1 billion for next year, has become the target of budget-minded critics.

President Reagan said recently that a mission to Mars should be part of NASA's future. But Robbins is sceptical. "I'm not convinced we know enough yet to do it," he told *New Scientist*. Radiation in deep space, the effects of weightlessness on human bones, and the psychological stresses of three years in space pose serious problems for astronauts on such a trip. □

Spaced out at star-wars laboratory

A CONGRESSIONAL committee has accused the US's Department of Energy of halting an inquiry that found evidence of widespread drug dealing at a weapons laboratory in California.

The investigation, called Operation Snowstorm, ended with the sacking of six employees of the Lawrence Livermore National Laboratory and the resignation of 10 others. Six were charged with possessing and selling drugs.

Allegations that escaped inquiry included claims that staff participated in a trafficking ring in Mexico and in operations at Californian backyard laboratories, run by Hell's Angels, that produced methamphetamine, or speed.

The drugs problem at Livermore, which is about 60 kilometres east of San Francisco, emerged in Washington at hearings called by the House Subcommittee on Oversight and Investigations. A report released by the subcommittee claimed that Operation Snowstorm had evidence that at least 127 staff at Livermore were selling and using cocaine, methamphetamine, marijuana and barbiturates.

About 8000 people, including 3000 scientists and engineers, work full time at the laboratory. Operation Snowstorm began in January 1986 and lasted eight months. It was organised by Livermore's own security staff. Police officers from the University of California acted as undercover agents.

One of the officers, Robert Buda, is reported to have identified 11 suspected drug dealers and 24 drug users. Many of them had "Q" security clearances, which meant that they could enter highly

restricted areas during their work.

So far, only one scientist has been implicated. Ronald Stump, worked as a chemist at Livermore for 26 years. He reportedly carried rolls of \$100 bills, held champagne parties, and owned several sports cars and yachts.

Stump, who had a high security clearance, left his job abruptly in April 1987 amid allegations of manufacturing and selling drugs and stealing precious metals worth \$11 000 from the laboratory.

John Nuckolls, recently appointed the director of Livermore, told the hearing that in future, security staff would check the financial records of employees suspected of selling drugs. There would also be random searches of workers' briefcases by police "sniffer" dogs. □

British skills famine sends Sony to Germany

SONY, one of the first Japanese companies to open a factory in Britain, last week cited the difficulty of hiring British engineers as a reason for building a new European headquarters in West Germany rather than in Wales.

The new operation, at Fellbach, near Stuttgart in West Germany, will manage all of Sony's European television business, including the design of new equipment. Until now, the consumer electronics company has directed these activities from Japan and carried out almost all of its R&D there.

Sony's largest and oldest European plant is at Bridgend in Wales. It employs 1400 people who make picture tubes and

complete television sets. Rainer Kurr, the general manager of Sony's European television company, said that the company had considered Bridgend for the new headquarters, but said: "We can hire engineers more easily in Stuttgart than in Wales."

Sony played down the political side of the move. But basing its business in Germany could sidestep any attempt by European governments to keep Japanese manufacturers out of new technologies such as high-definition television and satellite broadcasts.

Sony can also now rebut complaints that Japanese investments in Europe are merely "screwdriver plants", assembling components produced elsewhere. □

Afghan farmers count the cost of war

Omar Sattaur

NINE years after Soviet troops invaded Afghanistan, evidence has emerged of a largely unreported aspect of the war—the devastation of the country's agricultural base.

A survey commissioned by the Swedish Committee for Afghanistan suggests that the destruction of irrigation systems, grain stores and livestock was not an accidental by-product of the war but was part of a programme devised by the Soviet-backed government in Kabul.

Azam Gul, the director of the survey, was once a professor of agriculture at the University of Kabul. He said that there was barely enough food for people in the four-fifths of the country not controlled by the Kabul regime.

This would cause immense problems if the 5.5 million Afghan refugees living in Iran and Pakistan returned simultaneously, Gul said. "As soon as the countryside is secure, many will want to return. We hope we will not face famine if there is a mass movement of refugees," he said.

Preliminary results of the nationwide agricultural survey conducted last year reveal that the volume of food production is only half what it was in 1978 before the invasion.

One-third of the country's farms lie abandoned and the land under cultivation on those still worked has shrunk by almost one-third. Yields have fallen, on average, by 35 per cent.

The researchers interviewed 20 000 farmers in all 29 provinces controlled by Mujaheddin guerrillas. The results emerge from the 11 000 questionnaires remaining after the researchers had screened them for accuracy.

Apart from the direct effects of war, food

production has decreased because of a declining labour force. Young men are either fighting, injured or dead.

There are only four labourers—hired or within families—for every five that were available nine years ago. Farming families have had to rely on two-fifths fewer draught oxen than in peacetime. The proportion of farmers using fertilisers fell from 76 per cent to 53 per cent during the conflict.



Back to the land. Afghanistan must repair its war-ravaged farms

Before the invasion, Afghanistan's agriculture had been improving steadily. The country had become self-sufficient in wheat. Now, yields of wheat, maize and barley are down by one-third.

Two-thirds of the farmers who fled the country after the Soviet invasion reported that their villages had been bombed.

Another 36 per cent said that their irrigation systems were destroyed during the war. Almost one-third of the farmers said that land mines and bullets had killed livestock. Gul says that the most worrying consequence of the war is the deterioration in seed quality. For nine years, farmers have been unable to obtain improved seed. To sustain yields of staple crops, including wheat, maize, rice and barley, farmers in Afghanistan must renew seed every four to five years.

These crops do not pollinate themselves and so gradually deteriorate genetically, as they "outcross" with local varieties. Afghanistan is a centre of genetic diversity for wheat. Gul had, in 1970, set up a gene bank for Afghan wheat. He is unsure whether the bank has survived the war.

The replacement of facilities for breeding plants is therefore a priority in any programme of reconstruction. Gul has already begun to test the suitability of Pakistani varieties of wheat in 21 locations in Afghanistan.

The survey concludes that repatriation of refugees should take place over a period of years rather than months as the country would be unable to support a return in hordes.

"We estimate a need for 30 000 pairs of oxen. Even if we had the money to buy them, where can we find such a number?" Gul asked. International aid may have to pay for more agricultural tools, from hoes to tractors, he added.

Estimates of the cost range from \$1.5 billion to \$4 billion. Because the country is so varied in topography and geology, reconstruction will have to be tailored to the needs of districts or even individual valleys. □

Europe finds a new formula to fund particle physics

EUROPEAN research ministers last week agreed with scientists on a new formula for calculating how much money each member nation must contribute to CERN, Europe's centre for particle physics. The formula would reduce Britain's contribution next year by £10 million to £45 million.

The British government originally wanted to pay no more than £35 million, though a spokesman from the Department of Education and Science suggested that a contribution of £45 million was "in the right ballpark" for Britain to remain a member of CERN.

The idea emerged from a meeting of the CERN Council in Geneva. The total budget remains intact because the formula cuts Britain's contribution at the expense of Italy and Switzerland.

Britain and Italy could not agree when it should be implemented. The British government wants the system to take effect next year, the Italians in two years time. The CERN Council will meet again in

October to resolve the issue. At present, subscriptions to CERN are set for three years. The contributions of a member nation reflect proportionately the size of its gross domestic product (GDP).

However, because CERN's accountants calculate a nation's GDP by averaging it over the three most recent years for which figures are available, the outcome is out of date. For example, a contribution for 1989 might be derived by averaging the GDPs of 1985, 1986 and 1987.

This system can give a false indication of a nation's current economic strength. Britain, for example, complains that it is now contributing more than it can afford because its economy was stronger three years ago.

The new system of calculating contributions relies on more recent figures. It also allows contributions to be revised each year and calculates GDPs using weighted averages that take account of shifts in the state of a country's economy.

Initially, the new formula should reduce

Britain's contributions by about £10 million. But, if Britain's economic strength increases in future, it will have to pay more. Although the new formula meets Britain's requirements in the short term, the British government fears that CERN could drain the country's science budget as the economy picks up. It is therefore keen to cut CERN's costs in the longer term.

Britain's minister for higher education and science, Robert Jackson, said in Geneva that managers of CERN should implement the recommendations of an independent report published late last year.

The Agramas report, which examined how efficiently the centre is managed, recommended that 300 jobs at CERN should disappear between 1988 and 1990 and that the centre should recruit no more than 50 people each year.

The British government will decide on the country's future in CERN after the meeting of the CERN Council in October, which will consider the recommendations of the Agramas report. □

Uphill battle to save Filipino trees

Under President Marcos, foresters ransacked the Philippines for wood to sell to Japan. Corazon Aquino wants to replant the forests before the country's soils wash into the ocean

Debora MacKenzie

THIS MONTH, the government of the Philippines passed a bill that will begin reform of the country's system of land ownership. The President, Corazon Aquino, said the bill was the first step towards "the uplifting of the Filipino masses" and "permanent self-sufficiency in food for the people". But the prospects for that self-sufficiency are literally washing away from beneath the Filipinos.

The prospects for sustainable production of food in these mountainous islands are diminishing daily. Filipino scientists say that no amount of redistribution of land will solve the biggest threat to the ecology of the Philippines—the destruction of its forests and their soils.

Images taken from satellites show that the upland forests that covered most of the Philippines have fallen in the past 40 years from 75 per cent to 25 per cent of the land area. The majority of the trees were felled in the 1970s. Some smaller islands, such as Cebu, are virtually barren.

Aquino calls it one of her country's top three problems, along with poverty and international debt. In the past few months, her government has enacted several measures to halt deforestation.

One of the most devastating effects of the loss of trees in the Philippines is the erosion of hillsides. Without trees to bind the earth, the heavily populated hillsides of the islands have some of the highest rates of soil erosion in the world. Celso Roque, under secretary for research at the country's ministry for the environment and natural resources, says his country loses about a million cubic metres of soil each year.

Farmers on the denuded slopes lose their topsoil, which is deposited as silt, clogging the lowland irrigation canals on which the country's rice production depends. Hillside slums, such as those around Baguio, once known as the "city of pines", wash away with every monsoon.

The forests, like much else in the Philippines, suffer from the legacy of dictatorship. An inept programme of industrialisation has created too few jobs for a population that is increasing at a rate of 3.4 per cent per year. So most people remain farmers.

"If we distributed all the fertile land equally, it still would not be enough," says



John Nance/Magnum Photos

The Tasaday rely on the disappearing forests

Roque. Most of the government's attempts to halt deforestation are aimed at timber companies which chop logs for export, often to Japan. But much of the problem is with landless farmers who head for the hills in search of a plot to farm.

As in the Amazon basin and other tropical forests, loggers start the process of deforestation, carving roads through the forests. Landless people do the rest.

David Kummer, a geographer from Boston University in the US, says that there are an estimated 15 million people in the highlands. Nobody knows how many people are settled on permanent farms, tending their soils, and how many move around clearing new fields. "People talk about improving highland agriculture, but how can you change a system when you don't know what it is?" asks Kummer.

Scientists at the University of the Philippines study the farming habits of highlanders help them to be more profitable and to cause less damage to the forests. The

International Rice Research Institute, the home of the green revolution which has transformed the productivity of Asian agriculture in the past two decades, is based in the Philippines at Los Baños. It has recently started studying highland farming, especially a technique called intercropping. This involves planting alternate rows of different crops which complement each other. In particular, it incorporates leguminous crops, which fix nitrogen.

The aim is to develop systems of farming that regenerate the nutrients in the fragile upland soils. This should make it unnecessary for highland farmers to move fields every few years, clearing more trees each time.

It is possible to farm the soils of the former highland forests without exhausting them. Traditional "slash-and-burn" methods operated successfully in the region for centuries. People cleared patches of land by burning the trees, farmed the soil for a few years until it had lost its nutrients, and then moved on. Typically, the land had 25 years or more to recover before being farmed again. This sustained a population density of perhaps 30 people per square kilometre, says Roque.

Now, he says, the average density of people in the highlands is 119 per square kilometre. The lowlanders streaming

up the hillsides to find land "are ignorant of the traditional technology", he says. The government needs to develop methods of farming that can sustain more people on the highlands without destroying the soils.

"Some areas of remaining forest will be protected. Areas near them can reforest naturally," says Roque. But denuded areas will not recover naturally. The soil will wash away. If the soil is to survive, those slopes must be planted with new trees or given over to a mixture of forestry and farming, known as agroforestry.

The most direct approach to protecting the forests is to limit logging. In the days of the Marcos regime, says Roque, logging concessions were handed out as political favours. The beneficiaries became rich quickly. In the days after Aquino came to power, the loggers took advantage of the disarray in government to clear large areas of trees.

As the new government has slowly found its feet, it has changed the laws on logging.

"We won't hand out more concessions," says Roque. "But simply cancelling existing ones could open the way for illegal loggers and settlers... At least there is some prospect of regulating existing loggers."

Roque says that the government's rules, which allow only a proportion of trees in a forest to be chopped down, "should enable perpetual use of the remaining forests". Some foreign aid workers say that the rules are not working. The trees that are harvested include massive hardwoods more than a metre wide. As they are dragged from the forests, they frequently damage and knock down trees that are meant to stay in place. Also, roads into the forests cause extensive soil erosion and, according to some estimates, account for a tenth of the loss of trees in logging areas.

In any case, says Roque, most companies do not abide by the new rules. The big multinational companies generally stick to the law, but there are few effective controls on the smaller firms, each of which have perhaps a few thousand hectares of forest each.

Roque's ministry has allocated 400 million pesos (£27 million) to fighting deforestation. It is badly needed, says Roque. "We have one forest guard for each 4000 hectares. He has no jeep; not even a horse."

The Asian Development Bank has recently granted the Filipino government a loan of \$100 million, its biggest loan ever for forestry. Japan has loaned another \$50 million. Roque says the money will be spent on a programme of "social forestry". Traditional slash-and-burn farmers will receive rights to land as part of the Aquino government's reforms. Those rights will take the form of "stewardship contracts" to farmers that are renewable every 25 years and can be passed down by farmers from one generation to the next.

The farmers will be encouraged to make terraces on cleared land to prevent erosion of the soil. "We will assist farmers to cultivate the trees and market cash crops," says Roque. The World Bank and American development agencies are funding research projects in remote and deprived parts of the country, such as the islands around the Visayas Sea, to develop new farming systems.

Farmers will still have to run the gauntlet of illegal loggers who are often armed. The demand for wood in much of Asia, especially Japan, makes the rewards for logging high.

Locals felled illegally leave the highlands in truckloads, guarded by what amount to private armies. In 1986, Japan said that it had imported 3 million cubic metres of logs from the Philippines. Official records in the Philippines show exports to Japan of only 2 million cubic metres.

Until recently, the penalties for illegal logging have been no deterrent. But last year, the government decided to reward

informers with 30 per cent of the value of any illegally felled logs that were intercepted after a tip-off.

Earlier this year, the government made it illegal to export logs not taken from plantations. Among other rules, logging trucks will be allowed only on a few designated roads. The measures are all meant to give the government more control over the industry.

Sometimes, the law enforcers are corrupt. Logging is banned in an area covering 1000 square kilometres of northern Luzon that belongs to the government. Yet foreign forestry experts claim that a truckload of logs leaves the forest every day, right past the gates of a military camp. In another area of newly planted trees, charcoal companies have destroyed vast tracts of forest. Witnesses say that

are left. Much of these forests is covered by logging concessions. At a conference last February, Filipino foresters agreed that, by 1995, no more than 3000 square kilometres of dipterocarps will be left.

The government hopes to increase the number of dipterocarps, but scientists at the Forest Research Institute at the University of the Philippines at Los Baños say that the trees are difficult to propagate. "You never know when dipterocarps are going to flower, either what season or what year," says Jesus Bengzon of the institute. Some flower only every five or seven years. When produced, their winged seeds scatter fast and have to be collected rapidly because they will germinate only for two weeks. The seedlings are delicate.

The ministry is setting up nurseries all over the islands to try to propagate the dipterocarps. It is also cooperating with the big commercial loggers, which use a few "mother trees" to obtain breeding stock.

Scientists at the institute are trying to develop a system of tissue culture that will produce large numbers of seedlings without having to depend on the irregular seeding habits of the trees.

"The problem is that so little research is done on any of these trees," says Roque, even though some crops, like the Filipino mahogany, are worth millions of dollars a year. "We haven't even listed all the species we have," says Roque.

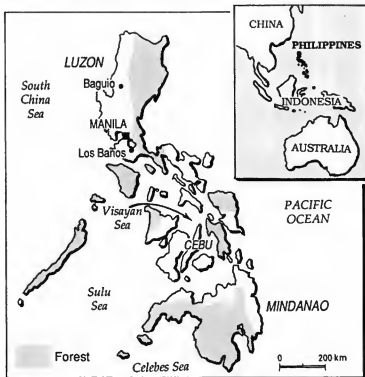
Aida Baja-Lapis, of the forestry institute, recently had a species of rattan named after her. *Calamus aida* had never been described before because, she says, rattan research ended in the 1920s. Now it is resuming with the help of British scientists from the Royal Botanic Gardens at Kew.

Meanwhile, Baja-Lapis says rattan is a promising crop for forestry in the highlands. Rattan furniture is a lucrative business in the Philippines, so much so that species of the tough forest creeper are becoming extinct. Baja-Lapis wants to plant samples of rattan from all over the country in a living gene bank in a rainforest reserve near the institute.

Replanting the deforested areas will not be easy. This year, says Roque, most planting will be contracted out to non-governmental organisations, mostly the small citizens' action groups that abound in the Philippines. "This government has shown it cannot reforest," he says.

An agreement has been reached between the government and the Catholic Church, most recently with the bishops of Mindanao island, to supervise the plantations and watch out for illegal logging.

The plantations will provide trees and secure soils. But they will essentially be monoculture. They will not provide the extraordinary genetic diversity held in the original forests. "I view tropical rainforest as a non-renewable resource," says Roque. □



the foresters pay a "toll" every time they pass a military checkpoint.

Much of the international aid for forestry in the Philippines will go to replace trees that have been chopped down. The environment ministry wants to plant 1000 square kilometres a year. Since May, logging firms have been required by law to deposit a sum of money equivalent to the cost of replanting the trees that they chop down. "If they reforest, they get the money back," says Roque.

His ministry is drawing up plans to plant trees in most areas of the country. It will concentrate on fast-growing trees including some indigenous species. New plantations of softwoods will supply the newspaper demanded by the newly freed, and extremely active, press.

Roque says that most of the new trees will be dipterocarps, a group of hardwood species that used to dominate the lower slopes and valleys of the Philippines.

"Most of the dipterocarp forests are gone," says Roque. The stands take 200 years to regenerate naturally, and only 70 000 square kilometres of mature forest

SCIENCE

Modified mouse may help to combat AIDS

A GENETICALLY engineered mouse may provide an animal model for the study of AIDS and may help scientists develop drugs against the disease.

The mouse, a healthy female, has given birth to offspring which carry the genetic information for the human immunodeficiency virus (HIV). These "transgenic" mice had symptoms similar to those that occur in AIDS. All of them died prematurely. Life would be much easier for researchers studying AIDS if they could find an animal that succumbs to HIV infection and develops AIDS. Chimpanzees, although they become infected with the virus, do not develop AIDS. They are also relatively rare and expensive to keep. A modified laboratory mouse would be the ideal solution.

John Leonard and his colleagues at the National Institute of Allergy and Infectious Diseases in Bethesda, Maryland, together with researchers from several other laboratories, started out with the genetic material for HIV. When HIV infects a human cell, the virus's own enzymes copy its genetic information, which is in the form of RNA, into DNA. This DNA then integrates itself into the DNA of the human cell. In this form, it is called the provirus. Once the cell becomes activated, the provirus directs the manufacture and assembly of viral proteins.

The researchers injected proviral DNA into fertilised mouse eggs. They then implanted the eggs into the uterus of a mouse, which acted as a surrogate mother. In 13 of the offspring, the researchers found HIV's proviral DNA. These animals were healthy and the scientists were unable to isolate virus from them.

When the team looked for antibodies to HIV, however, they found that one animal had a positive result to the test, called ELISA (enzyme-linked immunosorbent assay), which detects antibodies to the virus. On a more sensitive test, called the Western blot, the animal had antibodies to two viral proteins.

The researchers decided to breed this mouse with normal mice. This female has had four litters so far, producing 40 offspring. In 15 of these 40, the researchers were able to detect the proviral DNA of HIV. These 15 animals were ill and died prematurely. The researchers were unable to detect the provirus in the remaining 25 animals, which were all healthy.

Leonard, who presented the data at the Fourth International Conference on AIDS, held in Stockholm earlier this month, said that the 15 animals developed signs of disease by the age of 10 or 12 days. They were all smaller than they should have been and all died within a month of birth. All 15 animals from which the team could isolate provirus had symptoms analogous to those that people with AIDS experience. For example, several of the mice had enlarged lymph glands (lymphadenopathy). They also had a skin condi-

Sharon Kingman, Stockholm

tion which closely resembled psoriasis, with their tails, paws and ears dry and scaly. When researchers examined tissue from the lungs of these mice under the microscope, they found cells called lymphocytes accumulating around the blood vessels, an abnormality that closely parallels interstitial pneumonitis, a lung condition which is common in people with AIDS.



To make a "transgenic mouse" which has HIV in its cells, researchers insert DNA derived from HIV into a fertilised mouse egg. Some mice bred from such eggs show symptoms similar to those experienced by people with AIDS

One spin-off from this work may be an animal model for psoriasis. The skin abnormalities in these mice closely resembled this condition, both in general appearance and under the microscope. People with AIDS are prone to many skin conditions, including psoriasis.

David Pezen, one of Leonard's colleagues, said that the most interesting feature of the transgenic mice was the abnormalities in their immune systems. T cells, when stimulated by an antigen,

produce a substance called interleukin-2, which stimulates other T cells to grow. The T cells of people with AIDS respond less well than those of healthy people uninfected with HIV. When the researchers stimulated the T cells of the transgenic mice with an antigen, they found that these cells produced 20 to 25 per cent less interleukin-2 than cells from normal animals.

The team also looked at B cells, which are responsible for producing antibodies in response to an antigen, in the spleens of the transgenic animals. People with AIDS often have a condition called "polyclonal activation" in which their B cells inappropriately multiply into clones of cells producing antibodies, but fail to respond to a new antigen when one appears. In the transgenic mice, Pezen said, the researchers found "definite B cell proliferation, like the polyclonal activation in AIDS".

No one knows yet whether the transgenic mice will prove useful as a research tool. Leonard says that he believes the symptoms that the mice experience are due to HIV because he has isolated HIV from the sick animals but not the healthy ones. However, HIV cannot infect mouse cells (although it can attach to them) so the symptoms cannot be the result of true infection. The abnormalities may instead occur because the virus itself or some of the proteins it makes may be toxic.

The research team is now beginning work on applying its model. One obvious experiment would be to give the sick mice drugs to see whether these will prevent the symptoms from appearing. This would allow the researchers to evaluate potential drugs against AIDS.

The study also has another aspect. Out of the original 13 animals in which the researchers could detect HIV's proviral DNA, only five passed the viral material on to their offspring when mated with normal mice. One of these five animals was the female which gave birth to the 15 sick transgenic mice. The other four, however, produced transgenic mice without symptoms. This group of animals, Leonard says, may help scientists to understand what factors activate the proviral DNA in a cell which is infected but which has not started producing virus. □

Pheromones set trap for beetles

SEX pheromones could help to limit the spread in Africa of the larger grain borer, *Prostephanus truncatus*, a beetle which has destroyed up to 35 per cent of maize in store at some Tanzanian farms.

The borer has already spread to southern Kenya and Burundi and threatens to invade other maize-growing areas of Africa. More recently it was accidentally introduced to Togo and Benin. Scientists estimated that, if the borer became endemic in the maize-producing areas of Tanzania, it would cost about \$30 million to replace the lost crop.

Containment of the borer has so far relied on restricting exports of grain from affected countries, scrutinising stores for its presence and treating stored grain with pesticide dusts. Researchers from Britain's Overseas Development Natural Resources Institute at Slough last month tested a new mixture of two components of the borer's sex pheromone.

The researchers found that it was remarkably effective at attracting beetles. Julie Dendy, who tested the pheromone mixture in the Arusha area of Tanzania last month, said that 10 traps caught more than 3000 beetles. □

Barren planet bares its air

PLUTO, the most distant known planet in the Solar System, is not a barren rock. It has an atmosphere, astronomers have just announced.

On 9 June, the planet obscured light reaching Earth from a very dim star. The event, predicted a few years ago, did not turn out exactly as astronomers expected as they watched it from the South Pacific, Australia and New Zealand.

Several teams saw the star's light dim gradually as the planet passed in front, indicating that Pluto has an atmosphere. An airless rock would have blocked the starlight abruptly.

Many astronomers doubted whether Pluto was massive enough to hold an atmosphere, although observations by the Infrared Astronomical Satellite and in other studies had hinted otherwise (*New Scientist*, 1 October 1987, p 30). Pluto is about 2400 kilometres across, two-thirds the diameter of the Moon.

The extent of Pluto's atmosphere remains unknown, at least until astronomers analyse their data fully. Lawrence Wasserman of the Lowell Observatory in Flagstaff, Arizona, said that a planet's atmosphere blocks light from a star when its atmospheric pressure is more than a millionth of Earth's.

A pressure of this magnitude occurs 90 kilometres above the Earth's surface, but it could be higher or lower above Pluto's surface. Preliminary indications suggest that the atmosphere could be "fairly extensive", Wasserman said.

James Elliot of the Massachusetts Institute of Technology (MIT) said that the atmosphere appears to extend "for several hundred kilometres from the solid surface", although it is rather dilute, especially at its outer edges. He was unwilling to give more definite estimates.

At least eight groups saw the event. Observatories at Brisbane in Queensland, Australia, and Auckland and Black Birch in New Zealand were ideally situated to measure the star's fading.



Distant but not a desert. The furthest planet may have an atmosphere

A team from the Lowell Observatory in Arizona watched the event with a mobile telescope in Charters Towers in Queensland. Researchers from the MIT watched it in flight over the South Pacific in NASA's Kuiper Observatory.

The geographical distribution of observations suggests that the planet may have an atmosphere extending well above its surface. "Pluto alone is not big enough to create an occultation (blocking of starlight) both in northern Australia and southern New Zealand. Something is making it bigger," Wasserman said.

Pluto's moon, Charon, was in a position where it could not block the starlight simultaneously.

The next task for the astronomers is to analyse the data. Comparisons of light intensities with time should indicate how the density of Pluto's atmosphere varies with altitude. Other data should allow astronomers to calculate the diameter of Pluto more accurately.

Patchy stars

TWO ASTRONOMERS have found what they think is a new type of feature on a star. Clifford Toner, of the University of Western Ontario, reported the discovery at a recent meeting of the American Astronomical Society in Kansas City.

Toner and David Gray looked at spectral lines of several stars to study features caused by convection on their surfaces and the magnetic fields usually associated with them. They found that the intensity of the spectra varied.

The researchers concentrated on C Bootis A whose spectrum varies with a period of 6.4 days. Gray and Toner could not explain the observed effects by assuming the feature was a sunspot, which is darker than the feature. They got the best results by modelling an area that was only about 15 per cent fainter than the rest of the star's surface, and where convection was much greater. They called the area a "starchip" to differentiate it from a sunspot.

No one has reported similar patches on the Sun's surface, which, at 5780 K, is about 300 K hotter than the surface of C Bootis A. The star is also younger and rotates faster than the Sun. However, Gray says that similar features may exist on other cool stars. Intensity variations of about 1 per cent, similar to that caused by the starchip, have been seen for many stars.

Early warming

METHANE may have contributed to the warming of the world that occurred about 145 000 years ago, at the end of the last Ice Age but one.

Climatologists are interested in the contribution of methane to the greenhouse effect because its concentration in the air has increased from 0.7 to 1.68 parts per million (ppm) over the past 300 years, presumably as a result of human activities.

New measurements on bubbles of air from the Vostok ice core, drilled in Antarctica, show that the concentration of methane in the 15th century was very similar to the value before the most recent Ice Age. Even longer ago, however, during the previous Ice Age, the concentration was only 0.34 ppm.

The numbers are presented in *Nature* (vol 333, p 655) by a joint French-Soviet team. The researchers conclude that a combination of the increase in the concentrations of carbon dioxide and methane at that time and feedback effects could have accounted for half the warming that occurred as the ice melted, 2.2 °C out of 4.5 °C.

Nobody can be sure why the concentration of methane increased, but the team outlines two possibilities. First, bacteria that produce methane in freshwater wetlands may have become more active as the temperature rose. Secondly, as the world warmed and ice melted, there may have been more swampland around, in which the bacteria could operate.

Stay-at-home scorpions

THE DESERT grassland scorpion is a coward. *Paruroctonus uathensis*, spends most of its life hiding in a deep burrow to avoid being eaten by its predators. The scorpion, which is abundant in the grasslands of central New Mexico, ventures out only at night and then only occasionally. Richard Bradley, of the department of biology of the University of New Mexico, studied *P. uathensis* for 144 nights. He marked 270 of the scorpions with a fluorescent dye and found that, on average, only between 3 and 5 per cent of them were on the surface on any particular night (*Journal of Animal Ecology*, vol 57, p 533). This is much less than the normal figure of 10 to 15 per cent for other species of scorpions.

P. uathensis has many predators, including bats and owls, and it is also a cannibal. Its strategy seems to have enabled it to become abundant in an inhospitable environment.

Ancient trees warn of Carolina drought

TREES seventeen centuries old in the swamps of North Carolina indicate that the region may be at the beginning of a drought.

Researchers at the University of Arkansas, in Fayetteville suggest that the record droughts in North Carolina in 1985 and 1986 "could signal the end of the relatively wet regime that began in 1956". However, the researchers are careful to qualify their remarks with the comment that this possibility remains "highly speculative in the absence of a physical explanation for the changes".

The results come as farmers further west are becoming concerned by a drought described as reminiscent of the onset of dustbowl conditions in the 1930s.

The main cash crops in North Carolina include "Virginia" tobacco, peanuts and maize, which are all threatened by the drought. The ancient trees being studied are known as bald cypresses and grow along the Black River.

The researchers analysed the variations

in the width of the tree rings, which grew between AD 372 and 1985. They established a link between the width of a tree ring and the amount of rainfall that year, using meteorological records.

The evidence suggests that the climate during the growing season of North Carolina changes on a time scale of about 30 years with the longest period spanning 63 years and the shortest 21 years. The researchers found that 28 periods were significantly wetter or drier than the long-term average (*Science*, vol 240, p 1517). The team points out that about one-third of the 28 significant changes in the weather were sudden changes in the average rainfall from one year to the next.

North Carolina is on the edge of the region of tropical storms where a great deal of rain can fall in a short time, but there may also be much less rainfall if the storms follow a slightly different path. These changes may indicate something about the nature of past climatic changes on a global or hemispheric level.

Lithium limits the early Universe

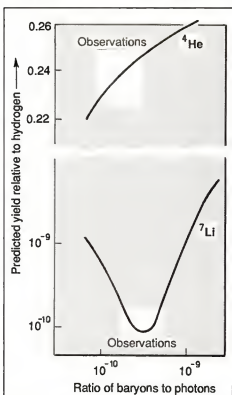
ASTROPHYSICISTS believe that matter in the Universe may have existed in two distinct states early in its history: one state consisting of hadrons dispersed throughout the Universe and another consisting of tightly knit clumps of quarks. Hubert Reeves, of the Astrophysics Institute in Paris, has recently set limits on the ratio of the densities of these two states.

According to theory, about 20 microseconds after the big bang, free quarks and gluons began to condense to form nuclear particles such as baryons and mesons, known collectively as hadrons. At the time of the quark-hadron transition, the Universe was still dominated by radiation in the form of energetic photons. The matter that was present, in the form of quarks and gluons, was only a minor constituent. It was out of this plasma that "islands" of hadrons—in effect bags of quarks confined by gluons—began to condense out and expand with the Universe.

Two different states of matter with different densities arose because, like a liquid boiling unevenly, the quark-gluon plasma did not change into hadrons everywhere at once.

Some of the quarks clung tightly together to form dense nuggets of matter which were left behind as the Universe expanded. Only later did the quarks in these nuggets condense into hadrons. As the Universe cooled, deuterium and lithium-7 formed in the low- and high-density regions of hadrons.

Reeves claimed at a recent symposium in Bologna, Italy, that the abundance of lithium-7 may provide a clue to the state of the early Universe.



Lithium-7 (${}^7\text{Li}$) unlike other big bang fossils, such as helium-4 (${}^4\text{He}$), has a dip in its yield curve. The observed abundance lies in the dip of the curve

Lithium-7 is connected with the transition between quarks and hadrons because, of all the elements produced soon after the big bang, it alone is sensitive to a Universe

with two distinct densities of matter. Calculations of nucleosynthesis in the big bang predict a dip in the yield of lithium for a particular density of hadrons. The observed abundance of lithium-7 corresponds closely with the bottom of the dip. This greatly limits the possible difference in the densities of hadrons in the Universe. According to Reeves, the phase formed by quarks could not have been more than 10 times more dense than the phase formed by dispersed hadrons.

The present abundance of lithium-7 fixes the density of hadrons at the epoch of nucleosynthesis, a few minutes after the big bang. By extrapolating this result, Reeves predicts that the present density of hadrons should be at most 5×10^{-9} grams per cubic centimetre. This figure is well below the density that astronomers need to explain the missing mass in the Universe as invisible hadrons. According to Reeves' hypothesis the missing mass must be in the form of more exotic particles than hadrons.

Some astrophysicists dispute whether lithium-7 existed right at the beginning of the Universe. If not, then Reeves' argument does not hold. But spectroscopic analysis of old, "population II" stars indicates that lithium-7 was not made by subsequent nuclear reactions in stars.

Astronomers have found that the abundance of lithium-7 is independent of the age of a star, varying by no more than a factor of two between stars. This indicates that the element was formed before the stars. By comparison, the abundance of iron, known to have been produced by stars, varies by a factor of 100 000 between stars.

Marcus Chown, Bologna

Cocaine adds to schizophrenic patients' paranoia

A NEW study confirms the view that people who abuse cocaine and amphetamines risk lasting mental illness. Malcolm Weller and colleagues from Friern Hospital in London, analysed data collected from 110 patients (*The Lancet*, 1988 vol 1, p 997).

The psychiatrists found that schizophrenics were more likely to have abused psychoactive drugs than patients with so-called endogenous mood disorders—disorders with no external cause such as manic depression. Both groups of patients had an average age of about 40. Almost half the 38 schizophrenics interviewed had abused drugs, compared with 21 per cent of the patients with endogenous mood disorders. Nine of the schizophrenic patients had abused drugs on more than 60 occasions. Only one of the patients with mood disorders had done the same.

The psychiatrists also found that schizophrenics who had abused drugs before they became ill tended to develop the disease earlier than those who had not abused drugs. There was an average age difference of 11 years.

The psychiatrists were most concerned by the large number of patients who had abused amphetamines and cocaine. Of the drug abusers that were schizophrenic, eight had abused amphetamines alone, one had



A sniff a day does not keep the bogeyman away. Those who abuse cocaine are particularly susceptible to paranoia

abused both amphetamines and cocaine and one had abused cocaine alone. Seven had abused the hallucinogens LSD and psilocybin. Only two of the patients with mood disorders had abused amphetamines and cocaine.

Although numbers are small and the specific effects of each drug cannot be separated from those of other drugs taken additionally, such as cannabis, Weller believes amphetamines and cocaine may be especially dangerous. Weller says: "We know that if you give entirely normal people amphetamines they have paranoid

delusions and hallucinations. We are worried that once you have triggered a state of psychosis, you can't switch it off in some people."

Amphetamines and cocaine increase the amount of dopamine—a neurotransmitter—released in the brain. Psychiatrists treat people who suffer from paranoid delusions and other schizophrenic symptoms by giving them drugs which suppress the effect of dopamine in the brain, such as chlorpromazine. "Amphetamines and cocaine have the opposite effect," says Weller.

The psychiatrists cannot say whether drug abuse is mainly the cause or effect of mental illness. There are many schizophrenics who have never abused drugs and many drug abusers who remain mentally well. But the researchers found that drug abusers without a family history of schizophrenia were just as likely to develop psychoses as those with a family history. "That makes it more worrying for the person without a history of illness in the family," Weller says.

TECHNOLOGY

Calls for ID cards worry health department

Meirion Jones

THE DEPARTMENT of Health and Social Security (DHSS) is worried that recent calls for compulsory identity cards may jeopardise an experiment it is conducting in Devon with "care cards", which carry medical records on a computer chip.

The department is worried that its cards may be seen as the forerunner to a national identity card which police, politicians and publicans have all called for recently.

A Conservative MP, Tony Favell, recently tabled in the House of Commons a bill to introduce identity cards which could be read by computers. The bill was defeated last week, but more than 100 MPs voted in its favour. The day after the defeat, Sir

Peter Imbert, the Metropolitan Police Commissioner, suggested collecting genetic fingerprints from the entire nation, and said he expected identity cards to be compulsory by the time the single European market arrives in 1992. He said: "If they were introduced and run by the Post Office or the Department of Health and Social Security, I would be very pleased."

Bob Livermore, who heads the experiment in Devon, says: "It is one of the things we don't want people saying, because of the fears people have." The experiment by the DHSS aims to test the cards only as medical records. "We can only speak for the

trial, not for what the government finally decides," says Livermore.

Robert Stevens, who organised the first British trial of "smart cards" as portable personal medical records, in South Wales, is also aware of the potential difficulties in introducing electronic identity cards. "If you're selling a product which is seen as restricting freedom you will get opposition, but if it is seen as improving healthcare its introduction will be easier."

Smart cards usually have a capacity of 8 kilobytes of memory. If a genetic fingerprint were encoded in the same way as a barcode it would take up several hundred bytes of memory, but would not be an instant way to identify people.

The National Physical Laboratory, in Middlesex, has developed a new system, called Veincheck, which scans the blood vessels at the wrist with infrared light to produce a crude equivalent of a fingerprint. This can be checked against the pattern stored in the card to prove identity. This pattern of veins is not unique to each person—the chances against two people having the same pattern are one in several thousand—but the system is cheaper than other methods of recording identity.

Systems which use fingerprints are more secure, but use up several hundred bytes of memory. The chance of two people having the same fingerprint is one in many millions.

Checking the pattern of the retina in the eye gives the greatest security—one chance in billions—and it uses only 35 bytes. □

Industry plans the home of the future

NEXT month, a dozen British companies, including British Telecom, ICI and British Gas, will be handed a secret report to help them to identify the technologies which will be needed in the homes of the 21st century.

They have spent £250 000 on the report, which has been prepared with the help of Applied Futures, a firm of consultants. It is the first stage of the Home of the Future project, and takes a very different standpoint from schemes such as the American "Smart House", Japanese "Home Automation" and the "Domotique" research programmes backed by the European Community. These start with today's gadgets, and assume that technological improvements will make them better and cheaper. They also consider the effects of wideband communications links to every home such as cable, satellite and fibre optics.

Home of the Future looks further ahead, to 2010, and considers economic and social factors in working out the demand for new technology. Experts from the different companies with specialist knowledge of current research get together in workshops with moderators who are deliberately naive and trained to ask "what if?" and "why not?" questions.

This has produced concepts such as the "hole in the wall". This controls the security of the house, which would come equipped with an identification system. As the owner entered, the lights and kettle would turn on automatically. Intruders would be greeted with the 21st-century equivalent of boiling oil. To cope with necessary repairs and services, consumer durables, such as washing machines would also be grouped around the "hole in the wall", and repaired from outside.

Some of the conclusions are not surprising. For example, it predicts that two-thirds of the homes in Britain will be wired up to wideband communications links by the end of the century. The report paints two scenarios for the year 2010, depending on which of two current social groups becomes dominant, an "inner-directed" or "outer-directed" group. The outers are the people that prospered in the

1980s, climbing the professional ladder, wearing designer labels and buying showy technology. These people are good news for the firms who sold CB radio yesterday and will be selling £200 satellite dishes tomorrow.

The inners were more dominant in the 1970s. They are slightly chaotic and unaware of fashion, but are now likely to have a word processor and to be fond of information technology. They are more likely to be "people-oriented" and want to talk to their friends over networks. This implies that homes may be equipped with fibre optic links, rather than satellite dishes, which are better suited for entertainment. □

Computer cracks chemical crises



George Hughes
Poole: next time might not be so lucky

WHEN a chemicals plant blew up last week in Poole, Dorset, showering drums of chemicals on surrounding streets, the fire brigade was lucky. It was able to find staff who knew what the chemicals were. But Britain's National Chemical Emergency Centre at Harwell is worried about accidents which happen at night, or when chemicals are in transit and no staff are at hand.

The NCEC has developed and runs a computerised databank on 60 000 chemicals called ChemData. It has just updated this system so it can cope better with urgent requests for information on chemicals. The callers often have only a name

or code number on the side of a drum or tanker to go by.

After an accident only some parts of a name may be left on a fire-damaged label. Until now, the NCEC had to print out a separate list of possible chemicals based on each scrap of information on the label. Then they had to compare these lists and work out the complete chemical name. This wastes vital time.

The new version of ChemData can accept incomplete snippets of information, do the comparisons itself, then pull out the full chemical name. It will then tell the fire brigade whether they need breathing apparatus, or protective gloves, and what precautions should be taken to stop the chemical reaching the sewers, for example. Fire Brigade is using microwaves to transmit this information directly to terminals in the cabs of fire engines.

Vehicles carrying hazardous chemicals across national frontiers do not always carry all the documents they need. Recent legislation says lorries must carry instructions on how to deal with every chemical they are carrying, in the language of every country the truck passes through.

The NCEC has recently developed another program which will produce this information in seven different languages—making it easier for lorry drivers to meet their responsibilities. □

Britain barks at the heels of robotics leaders

Susan Watts

BRITAIN is now back in the race to develop intelligent robots that will work in industry and, perhaps one day, in the home. Last week Britain's Advanced Robotics Research Centre (ARRC) was officially opened.

This is a £16 million project which aims to pull together disparate research on robotics and related technologies such as sensors, to give robots "sight" and "hearing", and interfaces which allow them to communicate with their makers. "The Japanese are moving ahead very fast. We have a lot of catching up to do," says Derek Palethorpe, acting director of the ARRC.

He is not happy with the amount of

money that the government has given to fund the centre. He says the staff and resources donated by the 16 organisations which currently back the centre has a value of £7 million. The DTI can donate up to 50 per cent of the total cost of a project, but decided to give a maximum of only £5 million.

Palethorpe is sure the list of sponsors will soon grow to at least 20, and hopes then to persuade the Department of Trade and Industry (DTI) to raise its contribution so it matches that from industry.

The centre is one part of the national

robotics initiative begun by the DTI in 1985. Britain was falling behind the Japanese in robotics development, as well as the US and the rest of Europe. So British companies came together to form applications groups, applying robotics to specific industries such as tunnelling, construction and underwater and nuclear projects.

The 16 organisations which support the centre include the government's Royal Signals and Radar Establishment, British Nuclear Fuels, GEC Marconi, SD-Scicon and Vickers Shipbuilders and Engineering.

All of those involved in the ARRC agree that it should make possible research which they could not have attempted on their own. "It will produce commercial results in three to five years time, instead of 10 to 15," says Gledhill.

Barry Ward is manager of the vehicle products group of Hunting Engineering, which builds remotely controlled vehicles. He says collaboration through the ARRC should bring forward his company's work by at least 12 months. Ward is hoping to equip his vehicles with artificial intelligence, so that they can move around a building and detect gas leaks for example, or act as a "guard dog" which could notice that its environment has changed when an intruder has entered the building. These robots could be used for dangerous surveillance jobs, such as factory inspection.

On Monday, the Health and Safety Executive issued guidelines on safety for people working with robots. The document describes safety practice in today's robot installations, and says employers must be flexible and assess the risks posed by individual robots. □

Japanese robots march to industry's beat

MOST of the 116 000 industrial robots at work in Japan are comparatively simple devices with only a few planes of movement. But Japanese researchers have set their sights on producing advanced robots which can find their way around hostile environments.

The country's best-known research programme in the field is the Advanced Robot Technology (ART) project, which began in 1983 and will run to 1991. In this project, researchers in several institutions and companies are working on three different types of advanced robots. One can inspect and maintain nuclear power stations; another can walk under water, and a third, six-legged "disaster prevention" robot, can fight fires.

Such machines will require a leap in computing technologies so the robots can

interpret data from their sensors.

The Ministry of International Trade and Industry (MITI) launched the project with total funds from government of 20 billion yen (£87 million) for eight years. Private industry, which contributes four-fifths of Japan's science spending, will take up any slack in funding.

Some of Japan's most adventurous work in advanced robotics comes from university groups. The best known is at Waseda University of Science and Engineering in Tokyo, where Ichiro Kato and his colleagues developed the Wasubot humanoid robot which could play the organ. The team's latest achievement is more useful: a robot arm equipped with sophisticated pressure sensors to detect breast cancers (*New Scientist*, 5 May, p 25).

Michael Cross, Tokyo

Seafood spray gives fruit that fresher feeling

AMERICAN scientists have discovered that a substance found in insect, crab and lobster shells can help to keep fruit fresh for up to nine months.

Ernest Hayes, a chemist from the Acadia University in Wolfville, Nova Scotia, has produced a water-soluble derivative of the polymer chitin, which he is using as a spray known as Nutri-Save.

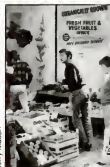
The spray forms a semipermeable coating on fruit which allows just the right amount of oxygen to pass through to keep the fruit fresh. The coating effectively puts the fruit to sleep by slowing down its respiratory process. In cold storage the fruit will keep far longer than normal, since each individual fruit is wrapped in its own environment.

Chitin is insoluble in most solvents, so the thousands of tonnes of crustacean shells thrown out every year by seafood processing plants have gone into waste dumps or back into the ocean. This has created pollution in many parts of the world, and has prompted researchers to look for a way to make chitin more soluble. When a derivative called chitosan was found to be soluble in dilute acids, Hayes began work on creating a derivative which would dissolve in water. This, he felt, could be very useful where acids are undesirable.

In medicine, for example, chitosan is used as a dressing. Hayes thought that a chitin derivative in a more neutral solution



Tapping the shells of crabs and lobsters has produced a coating for fruit which could cut storage costs



John Mason

would be more compatible with the human body. He made the water-soluble derivative N,O-carboxymethylchitosan by adding carboxymethyl groups to the chitosan.

After he had produced the water-soluble derivative, Hayes met a researcher at the Canadian federal department of agriculture who specialises in fruit storage. Chitin derivatives are known to kill fungi, so they decided to spray the new compound on some strawberries to see if they would keep longer. They found that the coating

restricted the flow of oxygen and the metabolite carbon dioxide into and out of the fruit.

Fruit is living tissue and requires oxygen or it dies, then rots. Sugars in fruit are oxidized by enzymes releasing carbon dioxide and water. The Nutri-Save coating slows down the metabolism of the fruit by restricting the flow of gases. Because the fruit receives less oxygen, they use up their reserve of sugar, and so decay more slowly. If the fruit is put in cold storage as well, then the shelf life can be almost doubled.

Its inventors say this technique is much cheaper and more efficient than current methods. Storage in a controlled atmosphere can do much the same thing as Nutri-Save, but needs large and sophisticated equipment. The store must be kept sealed, and the levels of oxygen and carbon dioxide carefully monitored to keep respiration to a minimum. Once the seal is broken, all the fruit must be sold within two weeks.

Using Nutri-Save, the seal is broken only when the film is washed off. It is biodegradable and can be used on many kinds of fruits including apples, peaches and pears.

Different fruits vary in the amount of oxygen they need in storage. Nutri-Save can be tailor-made for each type of fruit by varying the concentration of the chitin derivative. □

Toshiba paves the way for superconducting chips

THE RUSH by Japanese industry to find ways to exploit new materials which superconduct at relatively high temperatures has begun to bear fruit. A team set up earlier this year by the electronics giant Toshiba reported its first breakthroughs last week.

The team has found a new way of making a thin-film superconductor, a way to protect the surface of a superconductor with a thin layer of silver oxide and, most important, an electronic switch made from a sandwich of superconductors and an insulator.

The head of the research team, Akinobu Kasami, said that the breakthroughs paved the way for the development of superconducting electronic circuits, which will work far more quickly and efficiently than today's semiconductor microchips.

Several companies have already described ways of making thin films from the new materials. But Kasami said Toshiba's is the first which does not require annealing at 900 °C. Annealing produces a coarse surface.

Toshiba's process, which is called multi-target reactive sputtering, creates a superconducting compound by bombarding pieces of yttrium, barium and copper with a mixture of argon and oxygen. The result is a thin film of a compound of the yttrium, barium, copper

Michael Cross, Tokyo

and oxygen just 700 nanometres thick.

Jiro Yoshida, senior researcher at Toshiba's advanced research laboratory, said: "The most important thing is the ability to make quality thin films. Their surfaces must be as smooth as today's semiconductor wafers. As a result of accurate control we were able to produce the superconductor at 560 °C. With our method, the annealing process was unnecessary."

Superconductors made by the usual process have rough spots larger than 1 micrometre across. In contrast, Toshiba's thin films have a very flat surface with grains less than 0.3 micrometres in diameter.

The problem with thin films of superconductors is that they are chemically very delicate. Oxygen near the surface escapes and barium molecules react with water vapour in the air. The team at Toshiba stabilises the surface with a layer of oxidised silver. The researchers found that, because of the so-called proximity effect, the layer of silver shared the superconductor's properties.

This is the first time researchers have seen the proximity effect in high-temperature superconductors, Yoshida said. He thinks that the observation may provide clues to the mechanism of superconductivity, which is still largely a mystery.

These technologies led Toshiba's

researchers to what they describe as a world first—a basic electronic switch made by sandwiching a slice of insulator between a layer of high-temperature superconductor and a layer of superconducting lead.

The device exploits a phenomenon called the superconducting tunnel effect, which causes electrons to flow through an insulator between two superconductors. This is useful because, when the flow reaches a certain level, the sandwich becomes resistant to electric current. Researchers hope that this abrupt transition between different states can be used to store information in tomorrow's microchips.

Yoshida admits that the tunnel junction has no immediate application, "but we believe it is a very great step towards the application of superconductivity in electronic devices". The goal is a three-terminal switch, which will behave like a transistor but faster.

The team has not yet succeeded in making a junction entirely from high-temperature superconductors. "The thin insulator is easily destroyed when you put a high-temperature superconductor on the top," Kasami said. He does not expect any superconducting electronic device to be on sale for at least 10 years. □

Digitised maps pick out new stations

BBRITISH Rail (BR) is using a computerised mapping technique to help it to decide where to put new stations. If it proves successful, several new stations, chosen using the system, should be built within 18 months.

The technique is a "geographic information system", an increasingly popular way of combining local information with maps. This type of system has already been used to detect leukaemia clusters and to help local authorities and companies to plan for disasters. Experts now think that by 1990, the technology could be made for the price of a personal computer.

BR sifts through suggestions from frustrated commuters and isolated local authorities who want new stations, then decides, in a fairly arbitrary way, whether to investigate them further. It tried to improve the process by sponsoring research at a British university, aimed at predicting the demand for rail travel by examining census returns, but progress has been slow.

Then the South East Regional Research Laboratory, suggested that British Rail use a computerised geographic system.

It is 30 years since the first maps were digitised and stored on computer, and 15 years since Ordnance Survey produced its own digital maps. Despite this, fewer than 20 per cent of the survey's maps have been converted into a form which computers can read.

Last year, the government appointed a committee, chaired by Lord Chorley, to lay out the future of mapping in Britain. Its report, *Handling Geographic Information*, had one overriding message—a call for extensive use of these geographic information systems by both central



Let the software take the strain

and local government.

Using this digitised mapping technique, a user can superimpose data on a map on a computer screen. A pilot scheme at Redditch District Council lets planners start with a map of the whole county on their screen then zoom in to a particular ward, street or house, and look at detailed architectural drawings of a particular building. Planners can call up the names and ages of tenants to plan social services or modernisation of housing. □

EVE conceives a new computer

IBM has just spent \$40 million designing a computer system which it hopes will establish the company as the leading producer of mid-range computer systems and squeeze its arch rival, Digital Equipment Corporation, into second place.

IBM describes its new AS/400 series as its largest ever design project. It has taken two-and-a-half years to get the machine, variously codenamed Silverlake and Olympia, to customers. "It was analogous to inventing rubber and steel at the same time as designing an automobile and driving it around a test track," boasts Don Friedman, director of marketing for the system.

IBM's engineers designed and tested the AS/400 series with the help of a supercomputer called the EVE (engineering verification engine). The supercomputer, 100 times more powerful than IBM's largest general-purpose system, cut the design time by some 18 months.

Although much of the AS/400 is based on a series of computers that date from 1972, IBM produced a new 1-megabit

random-access memory (RAM) chip for the system and a memory board with components mounted on both sides. AS/400 computers also contain a database that is held in the system's own hardware. They use a new operating system called OS/400 which can address very large amounts of memory and automate some of the programming process.

In recent years, Digital's range of VAX computers, originally designed for scientific and engineering applications, have found increasing favour with commercial users, due largely to the competitive price of the system and the large amount of software available for it.

Although IBM had 250 000 users of two other mid-range computers—System 36 and System 38 which preceded the AS/400—customers were confused because the two systems are incompatible with each other. Last year, IBM brought out yet another mid-range computer called the 9370, which has the same operating system as the company's mainframes. □



IBM wants its money

UNTIL recently IBM has let rival firms which copy its personal computers get away with just a 1 per cent royalty. Now IBM is asking for a 5 per cent royalty from any firm which copies its new range of personal computers, the PS/2, plus back royalties of 1 per cent on all clones made previously. Firms which do not pay up will not get a PS/2 licence. IBM believes it has the clout to sue companies which default.

IBM has been lax about suing makers of personal computer clones because little of the new technology is hardware which can be protected by patents. IBM designed the PS/2, and its OS/2 software operating system, around new hardware technology called Micro Channel Architecture (MCA). This allows multi-tasking, which means the computer can handle several jobs at the same time. Micro Channel Architecture is hardware, so it is much easier to protect by patents.

But IBM has so far been vague about what the hardware is, and uses bland analogies with an hourglass with a wide neck and an office with several people doing the job of one manager.

This may well be because the basic concept of MCA seems obvious and difficult to patent. Most personal computers have a single data bus to carry data,

Learn to dig

A SURPRISING number of scientists and businesses have still not woken up to the fact that patent applications filed in Europe are published after 18 months. The technical secrets they contain are then no longer secret.

The significance of this remains largely unrecognised because searching for patents is like looking for a needle in a haystack. With this in mind the British Library, which houses Britain's largest collection of patents in its Science Reference and Information Service Library, is organising a three-day confer-

Europe's plants set patent precedent

A HISTORIC legal decision made by the European Patent Office (EPO) in April has set a far-reaching precedent for patents on living plants, so long as they are new and have been genetically engineered. Although the US Patent Office has granted a patent on a genetically engineered mouse (*New Scientist*, 21 April, p 23), the EPO has, until now, had a far less liberal approach.

In 1984, Agrigenetics Research Associates, of Boulder, Colorado, filed European patent application 122 791 in 11 countries including Britain. The company had found that it could modify plant tissues, and whole plants, by introducing useful genes from other species. This can give a plant resistance against disease, insects and herbicides, and alter the flavour of a vegetable.

In one experiment, Agrigenetics introduced a gene that codes for phaseolin, a protein found in beans, into sunflower and tobacco plant tissues. The gene can also be used to enhance the nutritional value of forage crops such as alfalfa, and common vegetables.

The gene is transferred by infecting the plant with a bacterium which contains the plant gene. This produces a tumour, the cells of which can be cultured to produce whole plant.

The EPO granted the Agrigenetics patent on 21 April. The company has a string of similar patent applications for living plants on file which it hopes will also be now accepted. □

handling digital code in both directions at such high speed that it often causes radio interference. Micro Channel has several parallel paths, running at lower speed, which handle data in bursts instead of sending bits out singly.

IBM may have the last laugh on any firm which tries to dispute its patent cover. The company has been working on multi-tasking for 25 years, and has filed patents on even the most minor developments. Patent indexes show that, last year alone, IBM filed more than

600 European applications. Even if the technical novelty is slight, IBM fills its patent specifications with vast quantities of technical detail.

A classic example is IBM's British patent 1 108 800. This covers work by Gene Amdahl, and fills three bound volumes on the shelves of the British Library vaults: equivalent to 300 ordinary applications. It could take clone makers until the next century to analyse IBM's patent folio in the hope of contesting any court action. □

Digital speakers

PHILIPS of Eindhoven is patenting a digital loudspeaker which could revolutionise sound reproduction (European patent application 256 593).

Modern hi-fi systems record sound in digital code and the latest amplifiers also work digitally. But, so far, manufacturers have had to convert the digital signal back into an analogue waveform before it is fed to a loudspeaker. Several inventors have tried to make a truly digital loudspeaker by combining many small loudspeakers in the same cabinet and feeding each with a separate signal corresponding to one bit, or piece of digital information. Because hi-fi sound is recorded with 16-bit words, 16 loudspeakers are needed for each stereo channel.

Philips says the problem can be solved more easily by clamp-



ence on patents as a source of intelligence for business and industry.

The courses, supported by the British Patent Office and Chartered Institute of Patent Agents, will be held at the Connaught Rooms, London, between 6-8 July. The price is £425 for three days. Details from Conference Services Ltd, Tel 01-740 8121. □

Patent information

Copies of patents, which contain fuller details and the addresses of inventors, are available from science reference libraries around Britain. For details of free public access and purchase price, contact the London

Patent Office at State House, 66-71 High Holborn, London WC1R 4TP (Tel 01-631 2525) or Science Reference and Information Service at 25 Southampton Buildings, London WC2A 1AY (Tel 01-638 1544).



A better speller

THE XEROX Corporation, and two other companies in the US, Microlytics and UFO Systems, have filed joint patent applications round the world (WO 88/02886) on a way to check the spelling of text from electronic typewriters and personal computers as the words are typed in.

Computers can check spelling at the moment, but only when a special program is used with the word processor. Electronic typewriters seldom have a built-in system to check the spelling and these cannot be added later.

The Americans have hit on a very simple way round the problem. They have devised a program to check spelling which is stored in a read only memory (ROM) built into a small box about the size of a personal stereo. This has input and output sockets which match the leads used to connect a keyboard to a typewriter or personal computer.

The box sits between the keyboard and the computer itself. This lets the ROM check the spelling of words before they reach the computer or typewriter. □

ing a flimsy plastic diaphragm between magnets, like the skin of a drum. These magnets create a steady field which interacts with a changing field produced when current runs through 16 concentric loops of metal foil, embedded in the surface of the drum.

Each loop is fed with a separate bit signal. The thickness of the metal varies from loop to loop, so that each has double the electrical resistance of the previous one. This matches the relationship between the 16 bits in each digital word. The drum then vibrates according to the current fed into the loops.

In theory the Philips loudspeaker can take a digital signal direct from a compact disc player and digital amplifier. □

Fighting for the forest ox

Earlier this century, scientists discovered a primitive wild ox—the kouprey—in the forests of Indochina. It could help to make domestic cattle resistant to disease—if it survives

Elizabeth Kemp

FOR THE FIRST time in nearly 20 years, Vietnamese scientists have sighted the kouprey, or grey "forest ox", of Indochina. Their fears that the primitive bovine might be extinct in Vietnam were allayed when at last they spotted a bull kouprey browsing in a densely forested area near the Laotian border.

Often confused with three other species of wild cattle in the region, the elusive animal's long dewlap gave it away, even in the fading evening light, said Le Khoi of the University of Hanoi. "We saw the kouprey at a distance of about 50 metres. It moved slowly and disappeared into the thick bushes and trees. Unfortunately, we couldn't photograph the kouprey because of darkness and my camera did not have a flash attachment." Scientists have been searching for the animal for decades, but up to now only local villagers, hunters and soldiers living in the booby-trapped borderlands of Indochina have seen the animal.

Biologists working in Indochina estimate the entire world population at between 100 and 300 animals. Researchers in Kampuchea believe that its kouprey number less than 200. In neighbouring Laos, which formed a department of wildlife in

1982, researchers think that up to 100 of the wild oxen still inhabit the dense forests along the Laos/Kampuchean border. In Vietnam, 27 kouprey probably survive in two small protected areas adjacent to the Laotian and Kampuchean borders.

Research on the kouprey in Indochina came to a virtual standstill for more than 30 years because of constant warfare in the area. Surveys resumed in Vietnam in 1975, shortly after liberation. Laos undertook its first official kouprey survey early this year, and biologists are now analysing the results. According to Laotian scientists, the kouprey is the country's only protected animal. In Kampuchea, where the kouprey has been the country's national animal since 1964, researchers have done little field work as a result of the fighting between the Khmer Rouge and Vietnamese and Kampuchean forces. In Vietnam the kouprey has joined the country's list of protected species, but a ban on hunting remains unenforced because the animals inhabit remote mountain regions where food is scarce.

Beginning in 1985, researchers surveyed some 30 localities in Vietnam's

central highlands and distributed thousands of questionnaires printed in the local languages. They also conducted dozens of interviews with "old people of wide forestry knowledge, chiefly those known as 'the tribe's elder wise men' in each area," said Le Vu Khoi. According to the data collected over the past two years, at least five herds numbering between 3 to 10 individuals, still survive in Vietnam.

With concern mounting over the steady decline in kouprey numbers from an estimated 200 in the late 1950s to these critically low levels today, Laos, Kampuchea and Vietnam have joined forces to save the species. An international agreement, drafted by Vo Quy of the University of Hanoi, was signed by ministers in all three countries in 1986. The pact sets out a management plan, including the establishment of reserves across frontiers, with cooperation to stop poachers from slipping between countries in pursuit of the kouprey and other endangered wildlife.

The countries' scientists also met for the first time in January in Hanoi at an international workshop on the kouprey conservation programme, where Le Khoi, who has led several kouprey surveys over the past few

years, announced Vietnam's "official" kouprey sighting. Hosted by the government of Vietnam, the meeting was funded by the World Wide Fund for Nature (WWF) and the Swedish International Development Agency.

Chaired by Vo Quy, dean of biology at the University of Hanoi, the workshop brought together for the first time experts from Vietnam, Kampuchea, Laos, Thailand, Malaysia, Sri Lanka, the US and Britain. Delegates at the workshop, including members of the International Union for Conservation of Nature and Natural Resources (IUCN) and representatives of zoos in Europe and America agreed that "the conservation priorities are a matter of the gravest urgency".

The participants drew up a "kouprey action plan" to be published by the WWF and the IUCN later this year. The first objective of the plan is to save the kouprey in the wild through the establishment of reserves spanning national borders. Because kouprey wander freely across the borders between Laos, Vietnam, Kampuchea and Thailand, the participants recommended that survey teams be able to cross frontiers when necessary.



Survivor: only a few hundred kouprey now exist in the forests of Indochina. They are rarely seen because they are partially nocturnal; this adaptation helps kouprey to evade human hunters

WWF/Peter Haffner

"Cooperation among Vietnam, Laos and Kampuchea is essential if the kouprey is to survive in the wild in Indochina," said Vo Quy, who plans to visit the environment ministers of Kampuchea and Laos to discuss the plan later this year.

Indochinese scientists also hope to establish a captive breeding population of 20 animals. Representatives of zoos around the world have agreed to advise on how to capture and breed the kouprey. In return, the three Indochinese countries will give viable embryos to the zoos. The countries will also help to determine whether the kouprey can benefit the livestock industry, by exporting 25 per cent of the sperm collected from founder bulls or their offspring to studies of hybrid cattle.

Participants at the workshop also specified who should own the offspring produced by the breeding programme. They proposed that the first generation of kouprey that results from embryo transplants should belong to the country of origin, but be regarded as on long-term loan so that a secure captive population can be bred around the world. Second-generation offspring or hybrids would remain the property of the country in which the births occur, but "on the understanding that zoos holding kouprey would continue to make such animals available without cost if these are needed for the re-introduction programme into wild habitat".

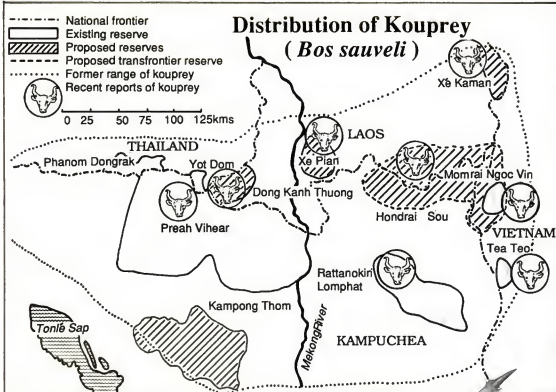
Participants in the workshop also pointed out that the kouprey was a "shared resource" but that each nation holds absolute rights over the species in its own country. They emphasised that each country had to set up its own conservation measures and committees.

The Thai delegation to the workshop offered to monitor movements of the kouprey across its border and to inform committee members of any sightings of kouprey. Following reports in the 1970s by villagers and soldiers that koupreys were crossing over the border from Kampuchea, Thailand created three nature reserves in the Dongrak mountains.

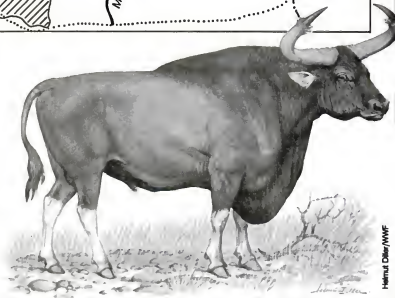
Everyone was impressed by the level of cooperation at the Hanoi meeting. "The workshop was remarkable for producing such broad agreement on complex issues by a wide variety of different interest groups," said Simon Stuart, species programme officer of the IUCN. "It could well prove to be a model for future recovery programmes for endangered species. But first it must be made to work. It is an ambitious and technically very difficult programme, but not to make this attempt would, in all probability, consign the species to extinction."

Charles Wharton, an American scientist who studied the kouprey in the early 1950s, suggested the species may be resistant to rinderpest, as one population of kouprey survived an epidemic which killed many domestic cattle in its range. Eventually, scientists hope to cross kouprey with domestic cattle, producing hybrids resistant to the disease.

Kouprey have many characteristics that are typical of



Kouprey unite Indochina: four countries have agreed to set aside reserves crossing regional boundaries to save the species, designated Kampuchea's national animal by Prince Sihanouk in 1964



forms alive in the Pleistocene, epoch, around 2 million years ago and could revolutionise evolutionary studies of the genus *Bos*, which includes domestic breeds. Nearly 50 years ago the only kouprey ever held for scientific study was shipped from Saigon to the Vincennes Zoo near Paris. Biologists marvelled over the wild ox, believed to be the world's most primitive bovine. It was officially named in 1937 by A. Urbain, director of the Vincennes Zoo.

For years, scientists debated the animal's origins, and in 1940 Harold Coolidge, a mammalogist at Harvard University, classified it as a new species, *Bos sauveli*, making it one of the last large mammals to be described. It may be one of the first to go. "If an agreement on transfrontier reserves and a captive breeding programme are not enacted by the end of this year, the kouprey may become extinct during the same century in which it was discovered by science," warns Vo Quy.

Subsequent attempts to capture a kouprey and set up a captive breeding centre in Indochina have ended in failure. Wharton, who travelled in eastern Kampuchea (then Cambodia) in 1951 under the protection of heavily armed troops, had hoped to spend a year in the animal's range. Unfortunately, security conditions restricted his study tour. A later mission, organised by Pierre Pfeffer, former president of



Charles Wharton/Coolidge Foundation/New York Zoological Society

Khmer choice: the kouprey was a favourite with the ancient Khmers, who carved many statues of it. Modern-day sculptors would find few live models to work from. The blurred image of a cow and calf (above) are from the only film in existence

WWF-France, with the assistance of Coolidge and Boonsong Lekhakul, Thailand's leading conservationist, ended unsuccessfully with the onset of the monsoon season, followed by the war in Kampuchea.

Pfeffer, who took the only reasonable photograph of a wild kouprey, went on five extensive expeditions to Indochina between 1964 and 1970, each lasting three months. At that time he said he had seen several herds of browsing kouprey, ranging from around 15 to 25 in a single group. Now Pfeffer says that he doubts whether such large herds survive. The animals are extremely difficult to survey, he says, because they are partially nocturnal, an adaptation which they have developed over the years to avoid humans. "Originally, they grazed in open forest," says Pfeffer. "They could be seen feeding openly during the day, unlike the guar, a close relative of the kouprey, which was always found in the deep forest."

Following reports by villagers that koupreys had crossed the border from Kampuchea into Thailand in 1982, a team from the Thai Wildlife Conservation Division immediately went to the area. The expedition came to an abrupt halt when the team's guide stepped on a land mine.

According to the scientists, villagers have different names for the kouprey (*Bos sauveli*), the guar (*Bos gaurus*), and the banteng (*Bos banteng*). Descriptions from villagers and scientists match Wharton's observations. Following his intensive field study, Wharton said that the kouprey is more alert and nervous than the banteng and even runs differently. "While it may gallop on occasion, its usual gait is a fast trot. It is not uncommon to see a herd of banteng heaving and lurching along in lumbering gallop, tails flying upward, while a kouprey bull trots serenely in their midst."

In addition to the male bull's long dewlap, or hanging folds of skin under the neck that can almost drag on the ground, its horns differentiate it from other species of wild cattle. Split at the ends, the horns give the impression of a pompon or frayed

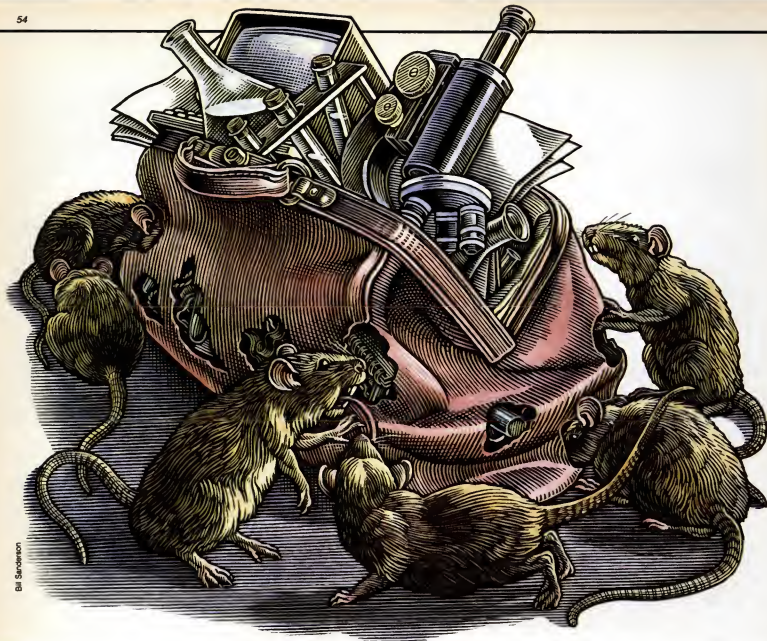
thread. Female koupreys have lyre-shaped horns that corkscrew upwards. According to people who have seen the kouprey, the females run with the grace of an antelope.

Invertebrate travellers, kouprey roam, often in female-led herds, up to 15 kilometres a night. During the dry season they retreat into dipterocarp forest and emerge in the evening to forage for food. They can be seen most easily at waterholes and salt licks, frequently drinking alongside banteng. They browse on grass, bushes and leaves. According to Wharton, koupreys mate in the spring (April) and calve in winter (December onwards). After hunting, the chief threat to the kouprey's survival is the low fertility of the female. When born, kouprey are reddish in colour and look similar to young banteng and guar. By five or six months of age, their coats are grey and their horns begin to sprout.

Wharton failed to bring a live kouprey back to the US, but he did obtain the only film footage of the kouprey, which was placed in the care of the archive library of the New York Zoological Society by the Coolidge Foundation, which funded his project and sponsored the production of a documentary film about it.

Vietnam's Centre for Resource Management and Environmental Studies, which is chaired by Vo Quy, is organising a major six-month survey of the kouprey in Vietnam to begin later this year. The government of Vietnam has invited biologists from Laos and Kampuchea to join the expedition. The WWF is paying for some of the field work, and additional support is being sought for technical training under the captive breeding programme. □

Elizabeth Kemf, an American journalist who has travelled throughout Vietnam for the past few years, is writing a book on the environmental effects of the Vietnam war (see her article in last week's *New Scientist*). She is editor of the international newspaper of the World Wide Fund for Nature, the *WWF News*.



Bill Sanderson

Research begins at forty

Since the National Health Service was created in 1948, it has hardly contributed to research. New proposals could give it a second chance

Richard Smith

IT IS a sad fact that the National Health Service, after 40 years, plays a paltry role in medical research. No one connected with the NHS needed the recent report of the House of Lords Select Committee on Science and Technology to tell them what they already knew. The committee has just completed what it billed as the first comprehensive review of medical research, and it found widespread despondency. "The overriding cause of the collapse of morale is the impression," concluded the committee, "... that neither the NHS nor the Department of Health and Social Security demonstrates any awareness of the importance of research nor is prepared to devote time, effort, resources to promote it..."

This lack of interest in research has characterised the NHS since its inception. There is no sign that attitudes are changing, either. Next weekend sees the departure of Christopher Booth from his post as director of the Clinical Research Centre at Harrow in Middlesex. One of Britain's greatest champions of clinical research (research based on patients),

Booth has fought and lost a battle for the heart of the research he thinks so important. As a result of a report that he has described as "naïve and superficial", the Clinical Research Centre is to be amalgamated with the Royal Postgraduate Medical School and transferred to the site of the postgraduate school at Hammersmith in West London. This will mean, says Booth, that clinical research will be moving away from the community and its common diseases, and into a hospital that provides highly specialised care, at just the time when the health service is moving in the opposite direction. And so will end a dream that had many of its origins in the mind of Harold Himsworth, one of the most successful secretaries of the Medical Research Council and a clinician rather than a basic scientist. He took over as secretary of the MRC in 1949, in the first year of the new health service. He was determined to create a vigorous centre for clinical research to match the National Institute for Medical Research, which has always been much more concerned with basic rather than clinical science.

The present MRC sees the fusion of the Clinical Research Centre and the Royal Postgraduate Medical School as a beginning rather than an end. But Dai Rees, the secretary of the council, says that he is "containing damage rather than planning for a bright future". He is particularly depressed about clinical research. "We haven't really got it off the ground," he says.

The history of research within the NHS is not glorious. True, there have been contributions to important achievements (see Box, p 56) and regular (somewhat patronising) comments from Americans about how remarkable it is that so much has been achieved with so little. In general, however, medical research in Britain has for the past 60 years been centred on the MRC, which has been best at basic science. Lloyd George's National Insurance Act of 1911 established that one penny for each insured person should go to a fund for research. The Medical Research Committee administered these funds. Like so many other research organisations before and since, the committee was stimulated by war: it blossomed in 1920 into the Medical Research Council.

In 1948, the National Health Service Act gave ministers powers to conduct research and to help others to do so. The government set up a joint committee between the health department and the MRC. A few years later the MRC set up a Clinical Research Board to oversee and encourage clinical research. In the 1970s, the MRC changed its structure and created boards for specific areas of science. The Clinical Research Board disappeared with, some have argued, a deleterious effect on clinical research.

The longstanding lack of interest in research within the NHS becomes evident when you observe how little the recent official history of the NHS mentions it. In this 479-page book, research comes up primarily in two contexts: researchers fighting for merit awards (extra payments made to hospital doctors under a confidential system), and the government trying to play down the harm done to health by cigarette smoking. *Plus ça change...*

The best way to illustrate the relative failure of the NHS's research effort is to compare it with that of a successful company such as IBM. Lord Flowers, a former secretary of the Science and Engineering Research Council and a member of the House of Lords committee that looked at medical research, says the committee assumed that the NHS needed to be doing research just as much as any innovative company. Worldwide, IBM spends over 10 per cent of its turnover on more than \$54 000 million on research. Yet the DHSS and the NHS together spend less than £30 million from a turnover of about £20 000 million—about 0.15 per cent. Walter Bodmer, the blunt-speaking director of the Imperial Cancer Research Fund, told the House of Lords committee that this was "little less than appalling". He went on: "Indeed, the overall expenditure on medical research (outside the pharmaceutical industry) is of the order of £300 million, namely about 1.5 per cent of the health service's budget, a level which would be considered totally inadequate by most major pharmaceutical companies to guarantee their medium- to long-term future." The consequences of failing to invest heavily in research are clear.

The grand plan: proposals for the NHS created more of a storm than the present cuts in it

The drug companies, which spend almost 20 per cent of their huge turnover on research, are some of Britain's most successful firms, while the industry that makes medical equipment, which has spent little on research, is ailing. The NHS needs new products (treatments), which will arise from basic and clinical research; it needs clinical and operational research to develop and test the new treatments; it must be able through operational research to make sure it delivers services efficiently; and, finally, it needs market research into public health to find out what the community requires. The NHS thus needs not just biomedical research but also research in many other disciplines, including epidemiology, behavioural sciences, statistics, economics and sociology.

Medical research attempts to cover a spectrum that ranges from basic work in molecular biology, through clinical research with patients and operational research, to public health research (which looks, for instance, at how poor housing harms health). Generally, the further you get from the molecule, the poorer the research effort becomes. The reason is lack of funding, status and trained researchers.

The House of Lords committee purported to cover the whole of medical research. In fact, it concerned itself primarily with the weakest aspects—operational and public health research. For basic and academic clinical research it argued for the status quo—with more money.

The main sources of funds for basic biomedical research are the Medical Research Council, the Wellcome Foundation and the cancer charities—the Imperial Cancer Research Fund and the Cancer Research Campaign. Between them, these organisations spend well over £100 million a year on basic research. A little more money comes in through the University Grants Committee. In addition, the drug industry claims to be spending around £50 million annually on “blue sky”

[illegible]

Plenty of room for innovation in the National Health Service

CLINICAL science rarely wins Nobel prizes, and the Royal Society does not elect many clinical scientists to its fellowship. Yet important innovations have arisen from work that researchers have carried out, at least in part, in the NHS. The following examples are not a "top of the pops" but an eclectic and personal selection.

In vitro fertilisation

Louise Brown, the first "test-tube baby", was born in Oldham in 1978. The work was the result of cooperation between a full-time NHS gynaecologist, Patrick Steptoe, a basic scientist in Cambridge, Bob Edwards, and their chief scientific assistant, Jean Purdy. Steptoe had been one of the first British gynaecologists to use the laparoscope, an instrument that allows the surgeon to see inside the abdomen and carry out procedures after making only a small incision. With the laparoscope, Steptoe was able to collect the eggs. The team succeeded in fertilising and reimplanting these in women with blocked Fallopian tubes. The "take home baby rate" of this treatment is still low, but the innovation was accomplished on what Edwards has called "a shoestring stretched over 180 miles" between Cambridge and Oldham.



The artificial hip

The name most commonly associated with the artificial hip is that of John Charnley, an orthopaedic surgeon who worked in Manchester Royal Infirmary in the 1950s and 1960s. Charnley did not develop the first artificial hip himself, but he made it an effective treatment by his work on its design and the cement used to insert it. A supremely practical man, he also developed mechanisms of creating a more sterile atmosphere in which to do the operations.

Rhesus haemolytic disease

Much of the work that allowed us to combat rhesus haemolytic disease was done by Cyril Clarke, Philip Sheppard and others

in Liverpool Royal Infirmary in the early 1960s. In this disease, a mother whose blood is rhesus-negative has antibodies against the red cells of her rhesus-positive fetus; the mother's antibodies destroy red cells in the fetus, causing anaemia, heart failure and sometimes death.

This problem was much rarer if the mother and fetus had different ABO blood groups. The mother was then less likely to form antibodies against fetal red cells, because any that gained access to her blood were rapidly destroyed.

The Liverpool workers had the idea that injections of anti-rhesus antibodies would also quickly destroy fetal red cells. This proved to be the case. Injections to women at risk around birth or after miscarriage or events such as amniocentesis greatly reduce rhesus haemolytic disease.

The double-blind randomised controlled trial

The double-blind randomised controlled trial may not sound like the most exciting of innovations, but it is one of the most important contributions to medical science this century. It is a technique that will distinguish treatments that work from those that do not. The only disappointment is that researchers have not applied it to more of the doubtful remedies offered by doctors. Austin Bradford Hill and Richard Doll at the Middlesex Hospital Medical School in London in the 1950s were both important in promoting the double-blind randomised controlled trial, and some of the work was done in the NHS. These two scientists also did much of the important work to show how smoking harms health.

The Wright peak-flow meter

In 1959, Martin Wright, who now works at the Clinical Research Centre at Northwick Park Hospital in Harrow, Middlesex, described his device for measuring the highest rate of flow that a person could reach in one forced breath. This measurement is particularly useful in assessing the severity of asthma. The meter's advantages over its predecessors were that it was simple, portable and accurate and did not require an electricity supply. The meter allows accurate minute-to-minute monitoring of asthma, which is important because attacks may come on quickly without full realisation of their severity. In 1978, Wright described an even smaller and simpler version of his meter.

Computer-aided diagnosis of abdominal pain

This is an NHS innovation that many hospitals have still not widely taken up. It was in 1972 that a group from St James's University Hospital in Leeds, led by surgeon Tim de Dombal, developed a computer system so that casualty officers and surgeons could diagnose patients with acute abdominal pain much more accurately. A trial published in 1986 confirmed that, even when used by non-enthusiasts, the system reduced deaths by a fifth and unnecessary operations on the abdomen by half. If the NHS as a whole took up the system, it would save £25 million a year.



Unemployment and health

The NHS offers remarkable possibilities for doing research in general practice. It is possible to follow the health of whole families over long periods, and controls for comparison are readily available. A long-running project on unemployment and health from one practice in Calne, Wiltshire, is one of the best examples available of this type of research producing internationally important work.

Norman Beale, a general practitioner, began his investigation into the effects on health of the closure of a sausage factory, thinking that probably his consultation rates would go down. With the help of a statistician, Susan Nethercott, he found from his controlled trial that the threat of unemployment increases consultation rates by 20 per cent and referral rates to outpatient departments by 60 per cent. Last month, these researchers published evidence showing that the increase in consultations and referrals is caused mainly by chronic illness (such as high blood pressure and heart disease) which is six times commoner among the unemployed than the employed. □

biomedical research that may bear fruit in years to come. Thus despite the protestations of the Royal Society and its president—as in the Dibley Lecture broadcast on British television earlier this year—basic biomedical research is doing relatively well. Most of this research takes place outside the NHS, in universities and research institutes.

The funding organisations are convinced that they are right to spend so much on basic research. Only by funding molecular biology will scientists crack cancer, they argue; only by understanding the brain will we combat dementia or schizophrenia. This philosophy is, however, under attack. Some science policy analysts suggest that the importance of the "science push" model of innovation has been exaggerated. Others point out that generous and long-term funding of

research into cancer has produced intellectually satisfying insights into the mechanisms of the cell but few benefits for those suffering from the commonest cancers: perhaps, they suggest, more of the money might be spent on prevention, relieving suffering or putting into practice what we already know. Finally, some argue cynically that researchers can have the results of basic science for free in the pages of *Nature*, *Cell* or *Science*. Britain is slipping in the international league of molecular biology, they say, and might better concentrate on research that can be done only in Britain—for instance, research associated with the NHS.

The most serious difficulty facing basic research is not lack of money but lack of people. And it is not so much that qualified scientists are draining away abroad, but more that

they are not entering academic science in the first place. Denis Noble of Save British Science has called this a "brain filter". Dai Rees says that bright young science graduates are being warned that research "is a mug's game". Merchant banks from the City have been actively recruiting science undergraduates in Oxford; such opportunities have tempted even medical undergraduates. "They see the City as exciting, and big hospital medicine as boring and insecure," one researcher told me. A London medical school was recently looking for a researcher to work on a programme backed by the MRC. It received no response to its first advertisement; the only reply to the second was from a researcher in Beijing.

The problems of clinical research, on the other hand, which is done almost entirely within the NHS, are mostly to do with medical graduates not being able to find the time and mental space to do high-quality research. Inter-calated degrees, which allow medical students to turn aside from the almost mindless medical course and do a year's science, are being cut on the insistence of the Treasury. Young graduates take great risks with their careers if they spend years getting a high-quality training in basic science. Yet the best clinical research needs people who can understand both basic science and patient care. The MRC is now providing long-term fellowships for a few medical graduates to spend time in both areas. Even for those lucky few, however, there will be worries about what will happen when the fellowship ends. It is becoming difficult to gain an academic career post and almost impossible to pick one up where the demands of patient care, teaching and administration will leave adequate time for research. The crumbling of the NHS is hitting research badly, because research is so much easier to abandon than patient care or teaching. Nor, it



Photo: AP/Wide World

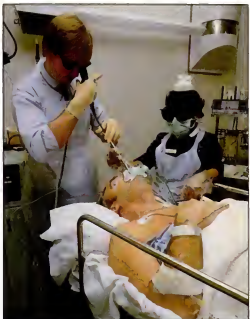


Photo: AP/Wide World

Going up in the world: City institutions are actively recruiting science—even medical—undergraduates. Hospitals lack glamour and, these days, security

appears, can the private sector compensate. There is no evidence that private hospitals are capable of anything but the most cursory research.

Doctors who risk a career in research always have available the temptation of a career in the NHS. Not only will this bring them better security and conditions, it will also bring the option of private practice, for which a six-figure annual income is not unusual. And it's easy to pick up money from a drug company for a little research on the side. Few researchers can resist these temptations for ever and, even if they can, their spouses often cannot.

Another difficulty with the NHS's research effort is the slowness with which many of the results feed back into practice. Sometimes the block is political (as with the evidence on how smoking and alcohol harm health) and sometimes ethical (as with anxieties over research on embryos). Most

Going up in Whitehall: the new Department of Health and Social Security



Photo: AP/Wide World

often, however, it is financial—think of *in vitro* fertilisation, for example. Another important factor is the failure of health workers to learn, understand and adapt. For example, Stephen Holgate, professor of immunopharmacology in Southampton, says that with modern care nobody need die of asthma. Yet 2000 people in Britain do so every year.

The type of medical research in the most parlous condition is that into the health service itself—operational and public health research, as the House of Lords committee preferred to call it. This type of research has limited funds, little status, few people to do research and no one to determine clearly what research should be done. The committee coyly noted that “the funding of applied research in medicine is known to be troublesome”. Robert Maxwell, director of the King’s Fund, an organisation that studies health policy, told the committee that “there is simply no critical mass of skill, people and funding in health services research and evaluation”. Alan Williams of the Centre for Health Economics in York told it that “far too much money is being spent at the moment on scientific and technical aspects of new developments and far too little evaluating their cost effectiveness”.

It was concern with health services research that brought Lord Rothschild into the story of NHS research. He proposed in 1971 that the MRC should give some of its funds to the DHSS for it to support the research that it thought important for the health service. His customer-contractor principle proved a flop because the DHSS was good neither at deciding what it wanted done nor at getting it done. In 1981, much of the money was returned to the MRC, which now has a health services research committee. But many people, including some members of this committee, do not accept that the MRC has the ability to cultivate this sort of research or the inclination to do so. Rees denies this, but can molecular biologists empathise with the need for research on incontinence aids or needle-exchange schemes for drug addicts?

Other bodies that have responsibility for health services research are the chief scientists’ offices in the DHSS in London and in the Scottish Home and Health Department in Edinburgh. The consensus is that the Scots do well while the English do badly. The DHSS has about £20 million to spend on research and much of it goes on supporting its units, of which there are more than 35. Two of the units—that in London for studying psychiatric problems in general practice

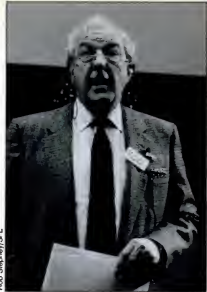
and that in Cardiff for research into the health needs of the elderly—are facing closure. The Chief Scientist, Francis O’Grady, a part-timer who runs the department’s research effort, is currently trying to free some of his funds. He wants to turn the organisation into a “top down” rather than a “bottom up” enterprise, so that it can fulfil what the DHSS calls “ministers’ priorities”. At the moment, the department is at loggerheads with many of its scientists because it is changing their contracts to give itself the power to stop publication of research that it has supported (*New Scientist*, 2 June, p 22).

The House of Lords committee was horrified that the Chief Scientist saw the main aim of his research programme as being “to provide guidance to ministers”. “The NHS needs a research programme also,” observed the committee haughtily, “and it is likely to be different [from research done for ministers], both in scale and kind.” Regional health authorities in England and Wales do have some paltry funds for research (about £8 million), but many regions do little or no research.

Recognising that the hugely expensive NHS had hardly any research capability of its own, the House of Lords committee recommended the creation of a National Health Research Authority. On paper, this body could overcome many of the failings of research within the NHS. It could identify priorities, bring together the many different funding bodies, commission health services research, advise on needs for researchers, promote peer review of clinical practice, and ensure that the results of research are disseminated and implemented. Many have welcomed the notion of the authority but those in the Chief Scientist’s office, and in the MRC, are likely to oppose it. There are also doubts about whether it would have enough money to spend, and some people have observed that other special health authorities (for training and health promotion) have had an unhappy time.

On the other hand, a centre that is to health services research what the Laboratory of Molecular Biology has been for molecular biology could bring a new dawn in British medical research. This is the view of John Butterfield, who was ennobled in the last honours list, becoming the first new medical peer for nine years. Formerly Regius Professor of Physic in Cambridge and an expert adviser to the House of Lords committee, he says: “Americans would flock to it as they once flocked to the Laboratory of Molecular Biology. We have such possibilities for this kind of research in Britain, particularly, for instance, in the care of the elderly.”

Many people still foster dreams of research in the NHS. London University, for instance, is making efforts to build a bright future for clinical research by bringing together the postgraduate medical institutes. The idea is to create the equivalent of the enormous American body which sponsors research, the National Institutes of Health in Bethesda, Maryland. But those interested in research have little to celebrate on the service’s 40th birthday, despite the brand new proposal for reorganisation now on the table. Will the outlook be any brighter when the NHS reaches its half-century—if it is allowed to get that far? □



Lord Butterfield: Britain needs a centre for health research



Lord Rothschild: his “customer-contractor” principle shifted money from the MRC to the DHSS to fund research—in vain

Richard Smith is assistant editor of the *British Medical Journal*.



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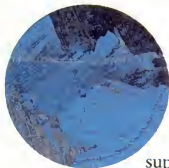
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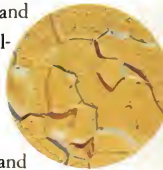
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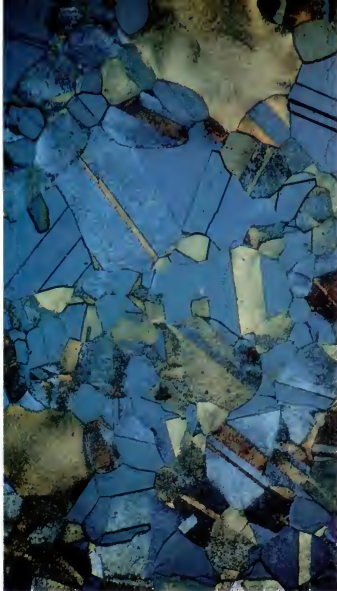
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Pollution beneath the Golden Gate

One of the world's largest and most beautiful estuaries is also one of the most polluted.
Will Californians save their bay?

Miranda MacQuitty

ONE OF the delights of San Francisco Bay is that it brings nature close to urban life. Water birds abound: from the cormorants that perch on the struts of the Bay Bridge, to the great blue herons that feed in shallow water only a few metres from the runways of San Francisco airport. The apparent harmony between nature and city is misleading, however, for the bay is far removed from its natural state. The estuary has changed drastically since the days of the Californian goldrush 140 years ago. Development of all sorts—urban, industrial and agricultural—followed close on the heels of the prospectors. So great is the diversity of the change that this is probably the most modified estuary in the US.

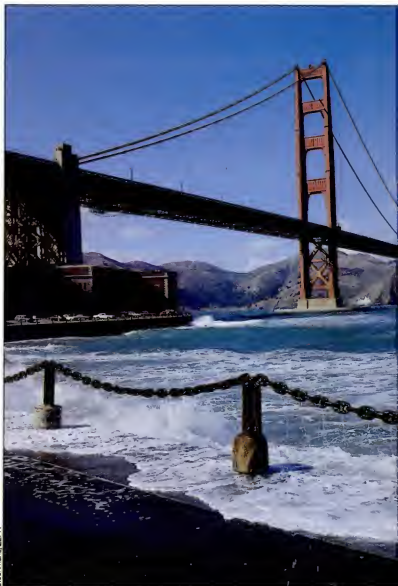
The estuary is the largest on the Pacific coast of the US, with a water surface area of 1240 square kilometres. Water draining off as much as 40 per cent of California's land finds its way into San Francisco Bay, via the Sacramento and San Joaquin rivers. The tidal estuary of these rivers extends from their joint inland delta, through to San Francisco Bay, which includes San Pablo Bay, Central Bay and South Bay.

Despite many campaigns to clean and restore the estuary, it still has severe problems. There are patches of heavily contaminated sediments, and fish and wildfowl have high concentrations of toxic contaminants in their bodies. The fisheries that made Fisherman's Wharf famous are in decline, and development threatens even the last remnants of San Francisco Bay's marshes. Although the damage might seem irreversible, the Environmental Protection Agency has begun a scheme to improve the estuary as part of its National Estuary Program. Established under the 1987 Clean Water Act, the programme aims to protect and improve water quality and enhance living resources in American estuaries. San Francisco estuary is one of the first six to be studied; the EPA has given a further six estuaries priority status. For the San Francisco estuary project, a better understanding of how human activity has affected this complex ecosystem will be crucial to its success.

The first big changes to the estuary began in 1848 at the start of the gold rush, when San Francisco became the centre for prospectors heading up to the Sierra Nevada to seek their fortunes. In two years the town's population grew from 400 to 25 000. All these people needed feeding, and the demand on local sources of food, including fish and shellfish, increased with the population. Native species of crabs, shrimps, salmon, sturgeon and flatfish were popular. But many of San Francisco's new inhabitants preferred the fish and shellfish that they had "back East". To cater for their tastes, some enterprising suppliers released eastern species into the estuary, such as striped bass and American shad, which quickly multiplied and soon supported large fisheries.

With the opening of the transcontinental railroad, in the 1860s, came vast quantities of eastern oysters, shipped to California to be fattened in the bay's productive waters. The eastern oysters never reproduced in the bay, but many other invertebrates that were accidentally introduced along with them thrived. Pests such as the oyster drill arrived in this way, while others, such as the destructive shipworm, came as stow-aways aboard the increasing numbers of ships that sailed into the bay. Today about 100 species of invertebrates and at least 20 species of fish in the estuary are introductions.

Despite the early success of commercial fisheries of both introduced and native species, the abundance did not last. By

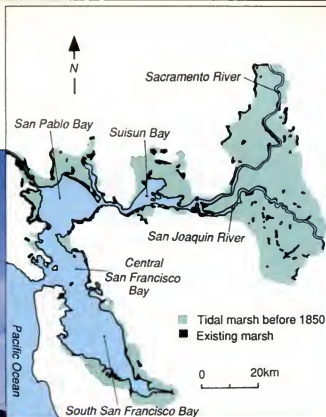


The Golden Gate straddles the most modified estuary in America. More than a century of abuse has left the bay with polluted water, toxic sediments and a threatened wildlife

the 1890s fishermen had to go offshore to find Dungeness crabs; not long after, the oyster fisheries failed. Commercial fishing of salmon, sturgeon, shad and striped bass was eventually banned to protect more profitable sport fishing. The sewage and industrial waste that poured into the bay no doubt played a part in the decline of the fisheries, and the enormous amounts of sediment let loose by hydraulic mining for gold made the problem worse. Between 1853 and 1884, when hydraulic mining was banned, millions of tonnes of debris clogged tributaries and rivers throughout the bay's catchment, spoiling salmon spawning grounds and causing flooding. In some parts of the estuary, the sediment settled into a blanketing layer a metre thick.

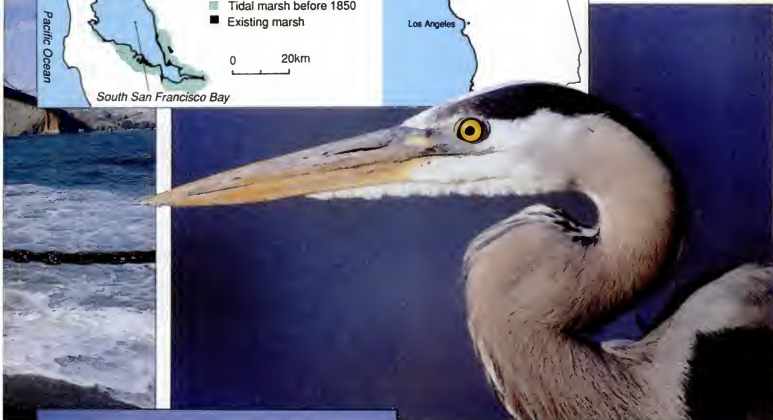
The addition of such huge quantities of sediment into an already shallow estuary created new areas of mudflats and marshland. But those were not enough to compensate for the

Shearman & Sterling/CEFA



San Francisco Estuary Project

Disappearing marshes: farmers and developers have reduced vast areas of wetland to tiny fragments. The remnants are the last refuge of the endangered saltmarsh mouse



Hanging on: great blue herons and cormorants can live with noise and disturbance. The decline of the once famous fisheries might finally see them off

rapid reclamation of marshes from the late 1800s onwards. By the 1920s, the freshwater marshes of the Sacramento and San Joaquin Delta had become rich farmland. The saltwater marshes of the bay were dyked to make salt pans, and were filled and built on by developers. Today only 6 per cent of the original 2200 square kilometres of wetland remain.

The destruction of wetland is the most obvious change to the San Francisco estuary. But scientists know little about how this loss affects the quality and productivity of its waters. The large populations of birds that feed on the marshes have suffered from the loss of their habitat. The situation is even worse for the endangered saltmarsh harvest mouse, which lives among the succulent plants (*Salicornia*) and grasses of the bay's marshes and nowhere else. Its survival depends on the survival of the remnants of the salt marshes. This secretive mouse tunnels among the saltmarsh vegetation

MacCurry International Collection

C. C. Lockwood/Oxford Scientific Films

and emerges only at night or when high tides force it to seek higher ground or to climb up plants. The salt-marsh harvest mouse is protected by the Endangered Species Act, but, says Jim McKevitt, of the US Fish and Wildlife Service, prospective developers are not above ploughing up the *Salicornia* to ensure that there are no mice on their site to halt development.

Apart from the threat to the bay's remaining marshland, there is also pressure to divert an increasing amount of fresh water from the estuary for irrigation and municipal water supplies. Before the gold rush, some 34 cubic kilometres of fresh water flowed into San Francisco Bay each year. Now gigantic dams, reservoirs and aqueducts regulate the flow of water along the Sacramento and San Joaquin river systems so that less than 40 per cent of the original flow reaches the bay. California's artificial water system is the largest in the world, with the capacity to hold 20 cubic kilometres of water. For this mammoth effort the state has received the dubious tribute of being a place "where water flows uphill towards money". Most of the water diverted from the estuary irrigates the farmlands of the delta and Central Valley. Massive pumps in the delta also extract water which is sent south to supply the cities and irrigation schemes of central and southern California.

There is much debate on how these water projects affect the biological resources of the San Francisco estuary. Such radical alterations to the natural flow of water certainly cause problems for the migratory species of fish. Dams have stopped salmon reaching their spawning grounds high up the Sacramento river system so that they have to be supplemented with fish from hatcheries. Each year many thousands of fish, including young salmon and striped bass, are lost to water diversion and irrigation pumps. Furthermore, water diversion appears to have reduced the abundance of the zooplankton on which the young fish feed.

The flow of fresh water influences the productivity of the upper estuary. In drought years, the microscopic plants—the phytoplankton—which form the base of the food chain, become scarce. Phytoplankton accumulate in the "null zone", where fresh water flowing downstream mixes with saltwater coming upstream. If the flow of fresh water is low, the null zone is further upstream, in the deeper and darker river channels rather than in the shallow well-lit waters of the delta. The lack of light in deeper water may prevent the growth of the phytoplankton.

The effect of water diversion on fish stocks is not clear cut because other changes to the estuary, such as increased pollution, overfishing and competition between native and introduced species, may all have played a part in the decline of the fisheries. The best-documented example is that of the introduced striped bass. Although caught only for sport since the 1930s, the striped bass is the most important of the remaining bay fisheries, worth about \$45 million a year. Since the 1960s, stocks of striped bass have decreased

Water flows towards money: dams, reservoirs and aqueducts divert water to California's farmland and cities. The once powerful flow no longer flushes sewage, or other pollutants, from the bay



Department of Water Resources



San Francisco Estuary Project

dramatically. Don Stevens, of the California Department of Fish and Game, firmly believes that the water projects have a profound effect on young striped bass. The adult population is about a quarter the size it was 20 years ago, and these adults may not be able to breed enough to stop the eventual extinction of the population.

The diversion of water also reduces the cleansing effect of fresh water, which ordinarily would help to flush out or dilute pollutants. Water in the northern part of the estuary, from central San Francisco Bay to the delta, has much shorter residence time than water in South San Francisco Bay, which is more like a tidal lagoon than an estuary. In the wet winter months, flushing of South Bay is increased by the greater inflow of water from the delta through the estuary; the residence time of water may be only a few weeks compared with several months in dry periods. Several studies have shown that the concentration of silver in clams from South San Francisco Bay is correlated with the inflow of fresh water, which suggests that the estuary's fresh-water flushing power helps to reduce levels of contamination in the local plants and animals.

In the past, the powerful water lobby paid scant attention to the effects that diverting water might have on the biological resources of the estuary and the quality of water in San Francisco Bay. However, the Californian legislature ruled in 1986 that the State Water Resources Control Board, which is



San Francisco Estuary Project



Bay Institute



The first step in restoration is to monitor pollution. Oil still "escapes" from refineries: Shell was responsible for this spill in April. Selenium causes deformities in ducks, and a range of toxins are blamed for skin lesions in striped bass



responsible for water rights, must take these effects into account when deciding how much water to divert from the estuary. To meet this commitment, the board is holding state hearings to review water quality standards. The aim is to give reasonable levels of protection to beneficial uses of the estuary that might be affected by flow, salinity and pollutants. By the summer of 1990, the board will make its final decisions on water rights. It may reduce the amounts of water diverted from the estuary if it decides that this would protect other beneficial uses, such as fisheries.

Pollution of San Francisco Bay has been a long-standing issue for the citizens of the bay area, who are among the most environmentally conscious in the world. Campaigns in the 1960s led to some major improvements in water quality—as a result of careful control of industrial discharges and improved treatment for sewage. Without the input of heavy loads of sewage, most of the bay's waters stay well oxygenated and the level of bacterial contamination is much lower—so that shellfish may be collected from some parts of the bay.

Environmentalists are still concerned about the large number of toxic contaminants that enter the estuary. Toxic metals leach from heavily irrigated soils in the estuary's catchment and are pumped out in municipal and industrial discharges. Pesticides are another problem. Farmers and fruit growers in the Central Valley apply large quantities of

pesticides to their crops—10 per cent of the amount used in the whole US—and much of it washes down to the estuary. Petroleum hydrocarbons enter the bay from urban runoff and discharges from oil refineries. Even polychlorinated biphenyls (PCBs), banned more than a decade ago, are still finding their way into the estuary, where they end up in sediments and fauna.

Last year, the Aquatic Habitat Institute, in Richmond on the east side of the bay, completed the gargantuan task of compiling data on all the sources of toxic contaminants that enter the estuary, under contract to the State Water Resources Control Board and the Environmental Protection Agency. The institute's efforts to assess the load of contaminants reaching the estuary were fraught with difficulties. Inputs from some point sources, such as discharges from municipal sewage works, are monitored regularly; but there are few data for urban runoff and input from rivers. Added to this, some of the available data are inaccurate because the monitors used unreliable analytical techniques. Bearing such uncertainties in mind, it seems that toxic metals mostly enter the estuary via rivers and runoff from rural land, whereas PCBs and petroleum-derived polyaromatic hydrocarbons may come mostly from the atmosphere.

The results of the Aquatic Habitat Institute's research show that the most significant toxic metals are copper, silver, mercury and selenium. The concentration of copper in the

The Army dredges up a problem

SINCE the Spanish first sailed into San Francisco Bay in 1775, seafarers have valued it as an excellent natural harbour. Today the bay and its delta hosts a wide variety of shipping: container ships and naval vessels, sports and commercial fishing boats, and yachts and motor cruisers. The US Army Corps of Engineers is responsible for dredging the channels to keep all this shipping on the move. This is no mean feat. Eight million cubic metres of sediment wash into the bay each year, and about 3 million cubic metres of it are carried out of the Golden Gate. The rest settles in the estuary, silting up berthing areas, harbours and channels which must be dredged to keep them clear. Apart from maintenance dredging, there are also new dredging projects to deepen channels and harbours or to create new marinas and docks. Each year about 6 million cubic metres of material is dredged and dumped at three disposal sites in the bay.

The army dredgers dump the largest amounts off Alcatraz Island in the central part of San Francisco Bay. The US Army originally chose this site in the hope that the tidal currents would sweep the sediment out through the Golden Gate into the Pacific. A survey in 1982 showed that this was not the case; the dumpsite was filling



San Francisco Estuary Project

Moving muck to move ships

up and in some places the water was only 12 metres deep, and possibly constituted a hazard to shipping. Part of the problem was that the dredgers were dumping rubble and large clods of sediment from clam-shell dredges, which the tides could not disperse. The Army now requires dredged material to be less dense and some has to be mixed with water so that it will disperse more easily. The dump ships also deposit their

carcasses more evenly over the site.

Recent proposals by port authorities and the US Navy to increase the amounts of dredged material substantially may require licensing of a new dump site. Schemes to deepen Oakland and Richmond harbours so that the next generation of deep-draught container ships can dock there, will generate about 6 million cubic metres of sediment. Dredged material from harbours in particular often contains high concentrations of toxic contaminants. No one knows what proportion of the contaminants is released in the process. Researchers at the Aquatic Habitat Institute estimate that anywhere between 1 and 10 per cent could be a realistic figure, but they point out that if the contaminants are mostly associated with the finer particles, these could settle out elsewhere to form "hot spots" of contaminated sediments.

Some material from Oakland harbour is now being dumped in the Pacific Ocean off Halfmoon Bay, south of the Golden Gate. This has already aroused complaints from the local fishermen. The especially toxic material that lurks in Oakland harbour will have to be disposed of on land as the EPA will not permit it to be dumped in the ocean. □

bay rises above the level recommended by the EPA and there are "hot spots", with high concentrations in the sediments in several parts of the estuary. Of more concern is that the copper discharged by some sewage works is in a form that is easily available to organisms, and it accumulates in the clam *Macoma balthica*. Concentrations of silver, from industrial discharges, are also high both in the water and the fauna of South San Francisco Bay. Silver can be very poisonous to marine life. Mercury is a persistent problem: there are natural deposits in the mountains of the Coast Range of California, and gold miners also used it in huge amounts in the mid-1800s during the extraction process. The concentrations of mercury in striped bass are high enough to warrant health warnings, which advise children and pregnant women not to eat fish caught in the region.

San Francisco Bay probably receives more selenium than any other estuary in the world, receiving a double dose from the naturally seleniferous soils of the San Joaquin Valley and from the oil refineries around the northern part of San Francisco Bay. Harry Ohlendorf, of the US Fish and Wildlife Service, and his colleagues found that the high concentration of selenium in Kesterson National Wildlife Refuge in the San Joaquin Valley caused severe reproductive problems in aquatic birds nesting there. The selenium comes from irrigation drainwater that was directed into the refuge from the San Luis Drain in 1978. The infamous drain, which was to run all the way to San Francisco Bay itself, is now closed. Nevertheless, selenium leached by heavy irrigation still finds its way, albeit slowly, into the estuary. Ohlendorf and his team's recent studies of diving ducks from the bay confirmed that they contain concentrations of cadmium, mercury and selenium, in particular, that are high enough to be toxic. Ohlendorf points out, however, that a combination of mercury and selenium strangely may be of benefit to some of the bay's birds, such as the surf scoter, because these metals can counteract each other's toxicity.

Ohlendorf, David Hoffman and their research team from the US Fish and Wildlife Service have established a link between polychlorinated biphenyls and the reproductive problems of black-crowned night herons which nest on Bair

Island, part of San Francisco Bay's wildlife refuge. PCB residues in the herons' eggs impair the growth of the embryos. The residues also cause problems for the bay's fish. Bob Spies, of the Lawrence Livermore National Laboratory, showed that high levels of PCBs in the eggs of starry flounders reduced their chances of successful fertilisation. What effect PCBs actually have on the flounder population remains to be seen. "Scientists all over the world are looking at such questions, but only a few times is it possible to say without a doubt that a problem is related to contamination, because variability in the environment is very high," says Spies.

PCBs are also present in the bay's harbour seals; concentrations are similar to those biologists believe are the cause of reproductive problems in grey seals from the Baltic Sea and ringed seals from the Gulf of Bothnia. Further studies on the effects of PCBs on the bay's seals are "crying out to be done" says Dave Phillips, acting director of the Aquatic Habitat Institute. Such studies rarely receive funding, possibly because they involve extensive field work and are rather expensive. A more cynical view is that seals are emotive subjects: proof that pollution is responsible for their problems might encourage more overt lobbying by environmentalists.

Scientists still have much to learn about how human activities affect the bay. While some changes, such as the destruction of wetlands, may be obvious, their effects on the estuarine ecosystems are not. Other changes, such as increased contamination of the water, sediments and biota, remain poorly understood. Only in a few cases is it possible to establish a causal relationship between a particular contaminant and a harmful effect. The future of the bay and its delta depends in part on whether scientists can provide more evidence to establish the consequences of such changes.

A better understanding of the estuary's problems will help policymakers to manage the environment more effectively. Inclusion of the San Francisco estuary in the EPA's National Estuary Program should accomplish this goal. □

Dr Miranda MacQuitty is a freelance science writer and marine biologist.

The membrane at the end of the Universe

In the quest for the ultimate theory of everything, theorists have given superstrings another dimension. Supermembranes may wrap up the Universe in 11 dimensions

Michael Duff and Christine Sutton



Supertheory II: Michael Duff's supermembranes go one better than (right) Michael Green's strings

IN 1984, a revolution rocked the rarefied world of theoretical physics. "Superstrings" had arrived, bringing with them the promise of the ultimate theory of everything, the holy grail of the knights of the theoretical round table. Four years later, superstrings probably still offer the best hope of discovering a theory to describe all physics. Recent work is beginning, however, to show that the theory of superstrings is not the *only* hope. A theory based on "supermembranes" might prove to be just as plausible.

Before 1984, physicists seeking a theory of everything had been thwarted in one aspect of their work, in trying to combine two well-understood branches of theoretical physics. On one hand, they had a perfectly workable theory of gravity, in the form of Albert Einstein's theory of general relativity. On the other, they had the so-called "standard model", which incorporates quantum theories for the strong nuclear force and the electroweak force. The strong force binds quarks together within particles such as protons; the electroweak force is manifest in the world about us as two forces—the electromagnetic force and the weak nuclear force responsible for radioactivity. Between them, the standard model and general relativity describe all four known fundamental forces.

The difficulties arose in trying to combine general relativity with the standard model—in other words, in attempting to form a quantum theory that described gravity as well as the electroweak and strong forces. Such "unified" theories always developed fatal flaws in the form of infinite quantities, and even worse, so-called anomalies.

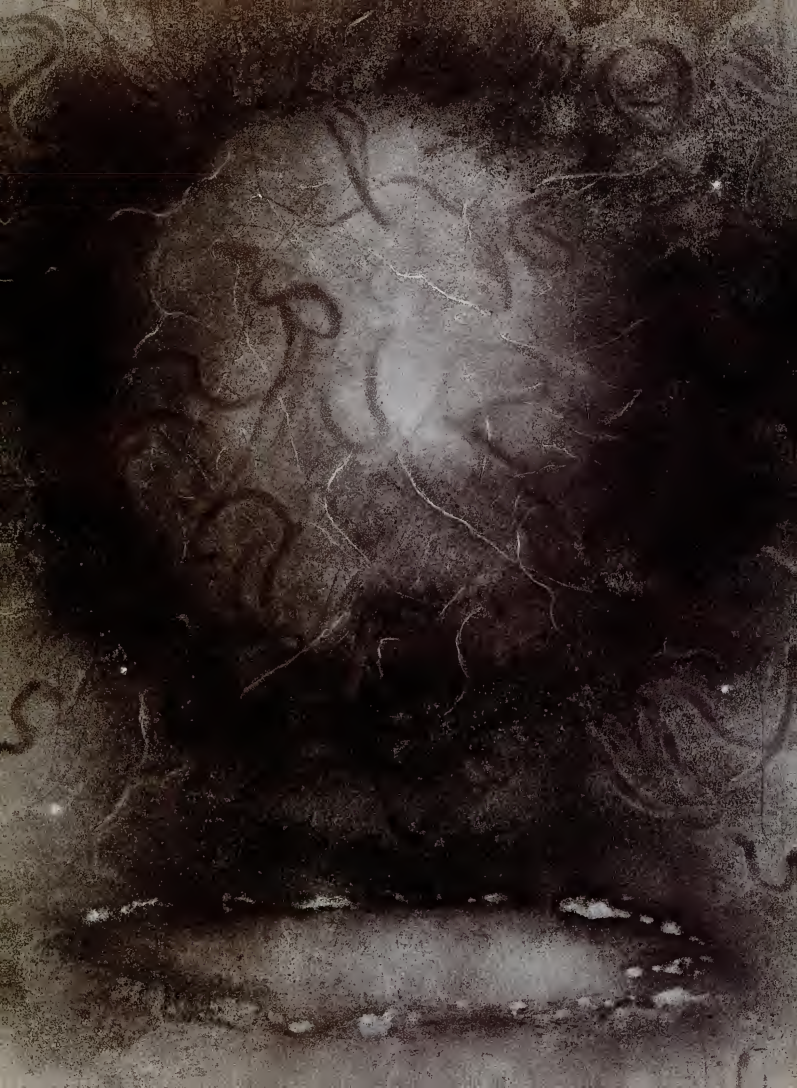
"Anomaly" is the word theorists use to describe what happens when a mathematical symmetry, displayed by a theory at the "classical", non-quantum level, becomes spoiled once they take quantum effects into account. Such anomalies may lead to inconsistencies, particularly when calculating the

probability of an event taking place—the approach that characterises quantum theory. You can only assign a probability to each possible outcome of a specific process, and this probability must lie between 0 (it will not happen) and 1 (it will happen). Even in quantum theory, however, we still demand that the total probabilities for all possible processes add up to one. If the presence of an anomaly prevents this from being true, then we must reject the theory as mathematically inconsistent. Candidates for a theory of everything must, therefore, first prove that they are "anomaly free", before we can even think of testing them experimentally.

If the search for a theory of everything is proving so difficult, you might ask: "Why bother?" The answer is that the quest has to do with more than simple aesthetics. As it stands, the standard model leaves open many questions. For example, why do the known elementary particles have the masses we observe? Why are there apparently two kinds of basic "building brick"—the quarks, which constitute the matter of atomic nuclei, and the leptons, which include the electron among others? The hope among many theorists is that a theory describing all physical forces might automatically answer such questions. Theorists would also prefer such a theory to be so well constrained as to be "unique".

The excitement that arose in 1984 came from the work of Michael Green, at Queen Mary College, London, and John Schwarz at the California Institute of Technology. They showed that in certain special kinds of theory, anomalies arising from quantum gravity cancel those due to other forces. Specifically, they cancel only in a very limited kind of "superstring" theory. Here at last was a remarkable hint of a theory that was not only free from anomalies but also possessed the desired quality of uniqueness.

What is a superstring theory? In theories such as those incorporated in the standard model, the fundamental



► particles or objects, are like points—they have no dimensions in space. As one of these objects moves through space-time, it draws out a one-dimensional “world line” through the point’s successive positions. In string theories, the fundamental objects are one-dimensional, like very thin strings. In this case, the objects draw out two-dimensional “world sheets” as they move through space-time (see Figure below).

To the superstrings, these fundamental objects must obey a symmetry known as supersymmetry. Supersymmetry relates the two classes of fundamental object required by the standard model—bosons and fermions. Bosons (named after Satendra Bose, because they behave in a manner that he first described) have integer values of intrinsic spin. This means that they have an angular momentum of $0, 1/2, 1, 3/2, 2, \dots$ times the basic unit. Fermions have half-integer spins of $1/2, 3/2, 5/2$, and so on. These particles are named after Enrico Fermi.

In the standard model, the building bricks of matter, the leptons and the quarks, are fermions. But the particles that carry the fundamental forces, such as the photon of the electromagnetic force, or the gluons that bind quarks together inside protons and neutrons, are bosons. Supersymmetry translates fermions into bosons and vice versa. In particular, it turns out that the net result of two consecutive supersymmetry operations is simply a translation in space-time.

The theory of general relativity involves similar operations on a large scale, leading to what we know as gravity. Thus, gravity is a natural consequence of supersymmetry, absolving us from the need to include it in some ad hoc fashion—which is why theorists are enthusiastic about supersymmetry, despite the lack of experimental evidence.

In this way, a superstring theory—describing string-like fundamental objects that behave according to the dictates of supersymmetry—automatically provides a quantum theory of gravity. But does such a theory work? The remarkable answer that Green and Schwarz found was: “No, not usually.” Only in a very special case does a superstring theory work. The superstrings must move in a 10-dimensional space-time. Further, we can use only one of two special mathematical symmetries to describe the fundamental interactions. According to Green and Schwarz, such a theory did indeed appear to be free from anomalies; it also seemed to be close to being unique.

At first sight, it might seem that a theory operating in 10-dimensional space-time should be nothing more than a mathematical curiosity. After all, we inhabit a Universe of four-dimensional space-time—three dimensions of space and one of time. However, as long ago as the 1920s, theorists had found that a theory based in more than four dimensions could describe a four-dimensional Universe.

In 1919, Theodor Kaluza, at the University of Königsberg in East Prussia, decided to solve the equations of general relativity in five dimensions rather than four. In doing so, he ended up with the usual solutions of Einstein’s four-dimensional relativity together with the equations of James

Clerk Maxwell’s theory of electromagnetism. It was as if electromagnetism was somehow the result of the “unseen” fifth dimension in space-time. (Why Kaluza took this step is unclear, but it was certainly one of the great moments of 20th-century science.)

A few years later, in 1926, Oskar Klein at the University of Copenhagen showed how this fifth dimension could be real and yet unseen. Four of the dimensions spread out in opposite directions towards infinity, along the axes of a graph in Cartesian geometry; the fifth dimension, however, is periodic, curling round and round on itself as if following a circle. If the radius of this circle were very small, then we would not see this extra dimension. To see this idea, think of a hosepipe. From a far distance, the hosepipe appears one-dimensional, but if you look at it closer, you can then see the circular cross-section (see Figure below right).

So by 1984, theorists were already accustomed to the idea of theories that began life in more than four dimensions but which had extra dimensions that were “compactified” in order to explain the familiar four-dimensional Universe. Physicists had studied various “supergravity” theories based on supersymmetry, together with the ideas of Kaluza and Klein, in up to 11 dimensions. Theories in 11 dimensions were particularly interesting because 11 is the maximum number of dimensions that supersymmetry allows. It seems that such a limit might have some special significance—that in fact we do live in an 11-dimensional Universe, in which seven dimensions have compactified to provide “internal” particle properties, such as electric charge.

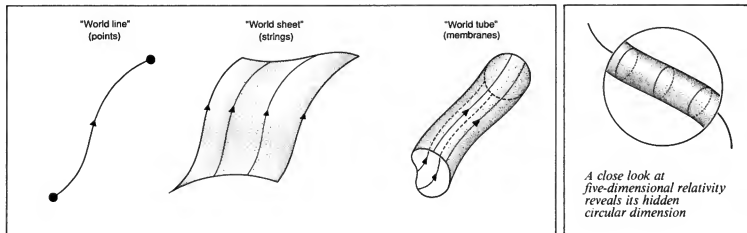
The trouble with 10

Why does superstring theory work only in 10 dimensions, when the upper limit that supersymmetry imposes is 11? There are also other questions that the superstring aficionados do not always answer. Is the 10-dimensional superstring theory really finite; are there no infinite quantities in it? Is it really unique? Is there really no alternative?

First, consider the question of whether superstring theory in 10 dimensions is finite. As yet, there is no rigorous proof, but most experts are optimistic that a proof will be forthcoming. This optimism has to do with the fact that strings are “extended” objects, unlike the one-dimensional “points” of earlier theories.

More disturbing is the question of uniqueness. In 1985, it became clear that there are as many as five theories of superstrings in 10 dimensions that are self-consistent. Each of these theories involves only one of the two allowed mathematical symmetries, but the theories differ slightly in detail. In one theory for example, the strings are open-ended, while in the others they are closed.

Already, then, the claim to uniqueness seemed to be weakening; in 1986, it became still shakier. There may be only five useful superstring theories in 10 dimensions, but what happens when the chosen theory is compactified—that is



when it is brought down to the realities of the four-dimensional Universe, with its six extra dimensions reduced to unobservable proportions?

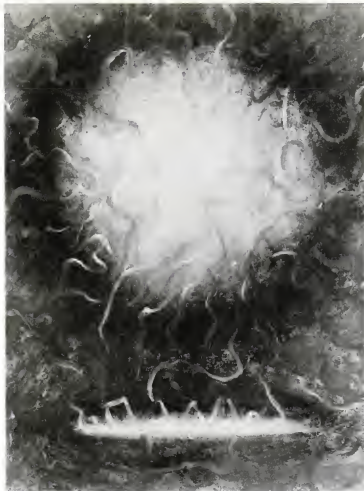
Kuman Narain, while at the Rutherford Appleton Laboratory, near Oxford showed that this compactification can lead to thousands of possible mathematical symmetries to describe the four-dimensional Universe. The "only two" of the original superstring theory were lost. Moreover, the resulting four-dimensional theory contains as many as 132 free parameters—in other words, values such as the masses of particles, about which the theory is silent.

Other theorists have now developed many variations of Narain's original construction, leading to yet more four-dimensional superstring theories. Indeed, no one yet knows how many there are, but it surely runs into millions. One intriguing idea is that these are not actually different theories, but are the descriptions of millions of different phases of one and the same theory. Just as water can exist in three phases, as ice, liquid and steam, so superstring theory may exist in millions of different phases, only one of which we happen to inhabit.

The idea is theoretically tidy, but it does not help at all in extracting experimental predictions from superstrings. After all, if there are millions of different possible universes, why do we happen to be living in this one rather than any of the others? Some cosmologists working with superstrings have even suggested that all the phases were created shortly after the big bang, and that they continue to coexist in different domains of our Universe. This view is difficult, if not impossible, to refute, but it sets a pessimistic note for the future of scientific enquiry. As Murray Gell-Mann, best known for suggesting the theory of quarks, has commented, physics would then be reduced to an environmental science such as botany.

It was against this background that a team working at the International Centre for Theoretical Physics in Trieste published their work on supermembranes early last year. Eric Bergshoeff, Ergin Sezgin and Paul Townsend considered objects that are, like strings, extended in space, but which differ from strings in being extended in more than one dimension. One of these was the supermembrane—an object with two spatial dimensions (hence a membrane) which moves in the dimension of time against a background of 11-dimensional supersymmetric space-time. Now this turns out to be particularly interesting because 11 dimensions are the maximum allowed by supersymmetry.

The idea for the supermembranes did not come straight out of the blue. James Hughes, Jun Liu and Joseph Polchinski at the University of Texas at Austin had written an earlier paper on the subject. Moreover, the original proposal that membranes might describe elementary particles dates back to 1962—to work by one of 20th century's greatest theoretical physicists, Paul Dirac at Cambridge University. After the



Lu Pyle

paper by Bergshoeff and his colleagues appeared, the supermembrane quickly became still more interesting.

At the department of applied mathematics and theoretical physics in Cambridge, another group of theorists, again including Townsend, made a different discovery about the supermembrane in 11 dimensions. Together with Anna Achucarro, Jonathan Evans, and David Wiltshire, Townsend found that only 12 extended objects are consistent with supersymmetry. One of these is the superstring in 10 dimensions, of the kind discovered first by Green and Schwarz. Closely related to it is the supermembrane in 11 dimensions.

Indeed, around the same time, a group of theorists visiting CERN, the European centre for research in particle physics at Geneva, showed that they could derive one of the five consistent 10-dimensional superstring theories starting from the 11-dimensional supermembrane theory. Michael Duff, Paul Howe, Takeo Inami and Kelly Stelle used the technique of "simultaneous dimensional reduction". In other words, they could decrease the dimensions of the basic object from two (a membrane) to one (a string) while the background of space-time changed from having 11 to 10 dimensions. This development suggests that it is the 11-dimensional theory that is the more fundamental.

This was all very well. But could a supermembrane theory even begin to make the same claims that had launched the superstring theories to fame? At first it seemed unlikely. There appeared to be good reasons why a supermembrane theory would fail, violating several of the basic conditions required of a theory of everything. Some of the difficulties were easy to overcome, but others seemed daunting.

In particular, the theory would need to accommodate massless particles, especially with those with a spin of 2. A quantum theory of gravity requires such particles to carry the gravitational force—the so-called gravitons. But early work suggested that a theory based on membranes could not allow these particles. In addition, the theory would, of course, need to be free from infinities and anomalies.

Progress came in August 1987, when Itzhak Bars, Christopher Pope and Sezgin showed that massless particles could exist in a supermembrane theory. Moreover, they found that only in the supermembrane in 11 dimensions did the massless particles include the necessary graviton, with spin 2. Here again was evidence pointing to the importance of 11 dimensions.

Around the same time, Bars overcame another problem. He showed that there are definitely unavoidable anomalies in all "super" theories, except those based on the superstring in 10 dimensions or the supermembrane in 11 dimensions. Green and Schwarz had shown that these anomalies cancel out in the case of the superstring in 10 dimensions. Bars and Pope went on to prove that, at least in some circumstances,

the anomalies would cancel out also for the supermembrane in 11 dimensions. The case for the supermembrane was looking stronger.

Meanwhile, Bergshoeff, Duff, Pope and Sezgin had shown that they could find stable solutions to the theory in 11-dimensional space-time that corresponded to a four-dimensional space-time plus seven compactified dimensions, which manifest themselves as a seven-sphere (S^7) (*New Scientist*, 2 June 1988, p 44). It appeared that the three-dimensional supermembrane (with two spatial dimensions and one time dimension) would form the boundary of the four-dimensional space-time of the real world, rather as the two-dimensional surface of a soap bubble encloses a three-dimensional volume—the membrane at the end of the Universe. Here at last was a tantalising “explanation” for why we live in a four-dimensional Universe.

There remains, however, the thorny question of infinities. The hope is that because, like strings, supermembranes are extended objects in space, then they will avoid the infinities that normally arise in theories based on points. The rigorous proof is turning out to be exceedingly difficult to find for strings, however, so it is likely to be even more of a problem for membranes. Indeed, some string theorists have attacked membranes on the grounds that they might introduce yet more infinities. This is because, in addition to the infinities in 11-dimensional space-time of the membrane itself, you have to worry about infinities in the three-dimensional space-time. (These kinds of infinities turn out to be trivial in the case of strings, because the world sheet is only two-dimensional.)

Some indications that the problem of infinities in supermembrane theories might be overcome have recently appeared. Towards the end of 1987, Miles Blencowe and Duff found that the symmetry of the four-dimensional space-time, produced in the compactification of the supermembrane theory from 11 dimensions, led to a striking conclusion.

The theory *must* be free from infinities in three-dimensional space-time; this much is guaranteed by the special kind of symmetry involved. Hermann Nicolai, Sezgin and Yoshiaki Tanii have independently reached the same conclusion; thus supermembrane theory has overcome another major obstacle.

What next for supermembranes? Whatever the future holds, theoretical physics will be the richer. Even if supermembrane theory proves to be wrong, theorists will be able to use that fact

to understand better the uniqueness of superstrings. If supermembranes prove to be right, the outcome will be still more interesting. The supermembrane may cast light on why we live in a four-dimensional space-time. Whatever happens, however, supermembranes, superstrings, or both, will have to confront experiment with testable predictions before the accolade of “theory of everything” can be finally awarded. And that may prove the most difficult hurdle of all. □

Michael Duff is a reader in theoretical physics at Imperial College and a staff member of the theory division at CERN.



Paul Dirac was the first to suggest that particles may be more like membranes than points

British Museum Natural History

One aphid . . .

. . . or two? Two apparently identical aphids but only one spreads virus infection to raspberries. The other feeds only on brambles.

Such knowledge can be vital for effective pest control. British Museum of Natural History staff solved the raspberry/blackberry aphid problem. The answer was found through biometry and chromosome analysis.

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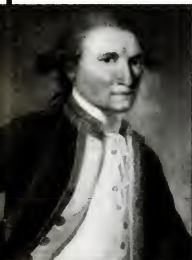
SPECIALIST BOOKS



The birth of scientific illustration

The Art of Captain Cook's Voyages (vol III)
by Rudiger Joppien and Bernard Smith, Yale UP, pp 669,
£125 (for both parts)

Dennis Puleston



Cook was the first explorer to take along scientific illustrators. The view of Resolution and Discovery near Tahiti, is by Cleverley

ALTHOUGH the Pacific Ocean had been partially explored prior to Cook's three voyages (1768 to 1780), the outside world knew very little about it. Described by an early historian as "a sea so vast that the human mind can scarcely grasp it", it was first traversed by Magellan, in 1521. But except for two small, low islets, he saw no land until he reached the Ladrone Islands, in the far western part of the ocean.

Subsequently, there were several Spanish expeditions, primarily to seek the legendary sources of King Solomon's gold. Then came the Dutch, with their prosaic quest for an expansion of trade. They were followed in

the mid-1700s by the British and French, with Byron, Wallis, Carteret and Bougainville, motivated mainly by expansions of empire.

In spite of all these expeditions, there was very little, if any, emphasis on scientific research. It, therefore, befell on James Cook to assemble as much information as possible on the people, the topography and the natural resources of the lands that he visited.

Accompanying Cook on the first voyage was Joseph Banks, a young man of considerable wealth, a botanist of distinction, and a fellow of the prestigious Royal Society. Banks brought with him a retinue of naturalists,

an artist and servants. Sydney Parkinson, the artist on the first voyage, on the barque Endeavour, was required to record visually the scientific observations of the expedition. The great interest and excitement generated in Britain's learned circles by the documentation of the voyage prompted another artist, William Hodges, to be enlisted for a second voyage, on the Resolution and Adventure.

Thus, the pattern had been set. When the third and last of Cook's voyages, on the Resolution and Discovery, sailed in July 1776, a young artist of Swiss extraction, who had already exhibited in the Royal

Academy, was on board. Although John Webber was practically unknown in Britain, the selection was a wise one. Webber was a very industrious, talented and versatile worker. During the course of the four-year voyage, and subsequently on his return to England, he produced hundreds of portraits, landscapes and sketches of artefacts, fauna and flora, carefully executed in oils, watercolour, wash, gouache, pencil, charcoal, pen, or combinations of several of these media.

In addition to Webber's own efforts, there were also a lesser number of works contributed by William Ellis, a young medical student who was enlisted as surgeon's second mate on the Discovery, until he was transferred to the Resolution about eight months later. He worked mostly in pencil and watercolour, making drawings of native people, landscapes, and subjects related to the natural sciences, both in the south and north Pacific Oceans.

Following the completion of the third voyage, Webber was presented to King George III, and his reputation grew accordingly. Banks, now knighted and President of the Royal Society, was vitally interested in the findings of the expedition and gave Webber every encouragement in the completion of his work. Thus, Webber converted many of the field sketches into finished paintings. The Royal Academy exhibited some of these following the publication of the official account of the voyage by the Lords of the Admiralty. Many of Webber's and Ellis' works were eventually made



State Library of New South Wales

available as engravings.

All this material, together with the many notes appended to the works of art, has been assembled here by Rudiger Joppien and Bernard Smith. Each volume of *The Art of Captain Cook's Voyages* includes a critical and analytical account of the professional artist associated with the relevant voyage. Joppien and Smith give a full descriptive catalogue of the works reproduced in each volume. They have arranged the works chronologically to provide an illustrated annotated account of each voyage. They have also adapted much descriptive writing from Cook's own voluminous logs.

These volumes serve to provide a magnificent supplement to the late J. C. Beaglehole's exhaustive biography, entitled *The Life of Captain James Cook*. So now we have complete coverage of the three historic voyages, providing a perspective on a world we will not see again. But by these means one can still derive a faint sense of the astonishment and wonder that must have gripped thosefortunates who accompanied the great navigator



A deer of Princes Island, drawn by John Webber in 1780. Princes Island is in the Sunda Strait between Sumatra and Java

on his expeditions.

The unspoiled beauty of the lands they visited and the people they encountered is gone forever, but we are now able to gain a better understanding of those exciting years of discovery. Of particular significance is a set of landscapes of the island of Krakatoa in Sunda Straits. On 27 August 1883, the island disappeared during the greatest volcanic explosion in recorded history.

Another of Webber's paintings is of special poignancy. It depicts the death of Cook on the beach of Kealakakua Bay, on the island of Hawaii, on 14 February 1779. Because Webber was not present at the scene of the tragedy, he composed the scene later from eyewitness accounts. He shows Cook just prior to being stabbed in the back, almost completely surrounded by enraged natives, his hand raised in an appealing

gesture to his men in the boats, to prevent them from firing on his antagonists. Whether true or not, this is just one more tribute to the man's humanity. We must always remember that his care for his men was such that he never lost a single man to scurvy, an extraordinary record in those days.

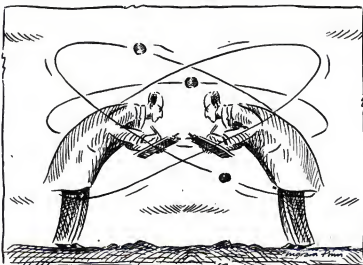
The two compilers of this massive collection are to be commended for the exhaustive task they have accomplished. They are both eminently qualified. Joppien has been engaged in a research project in West Germany on visual documents relating to early travels; he has published widely on Cook's voyages.

Smith, of the University of Sydney, Australia, has developed a continuing interest in the art generated by Cook's voyages. He has also co-edited a recent volume, *The Art of the First Fleet*, a history of the drawings and paintings generated during the arrival of the first shipment of convicts to Australia. The book covers the early days of the settlements, and the remarkable native people and wildlife encountered by the new arrivals. □

Mao's lesson on microscopic physics

Symmetries, Asymmetries, and the World of Particles
by T. D. Lee, University of Washington Press, pp 66, \$9.95

Peter Higgs



C. N. Yang for their theoretical work on the violation of right-left symmetry in nuclear beta decay processes. Here, he describes how right-left and time-reversal symmetries, long taken for granted by physicists, break down at the level of nuclear and elementary particles. Such asymmetries seem to be inherent in the laws of the microscopic world.

On the other hand, as Lee describes, there are in elemen-

tary particle processes other asymmetries, with respect to symmetry operations of a less obviously geometric kind—known as gauge symmetries. These have turned out to be absent from the underlying dynamical laws. That is to say, the underlying laws are (unexpectedly) symmetric. The asymmetry physicists observe in the particle processes they attribute to an asymmetry of the "vacuum". This phenomenon is

known as spontaneous symmetry breaking.

Lee gives a very clear account of how the concept of vacuum in physics has evolved. In modern quantum field theory, it means simply the state which remains when all matter is removed: such a state can have residual physical properties, carried by the fields of which the matter particles are quanta.

In the second lecture, Lee gives a more general survey of the present state of particle physics. He discusses both the current theories of the underlying constituents and their interactions and the way in which physicists have arrived at the theories via an interplay of theory and experiment. Again, he stresses the roles of symmetry and of the strange properties of the vacuum in enabling theorists to understand such surprising features as quark confinement. He ends with a brief account of how experiments utilising heavy-ion collisions promise new insights into quark dynamics, by creating an exotic variant of the vacuum.

I came away from reading this slim volume regretting that the author has not yet found time to write a fuller account of symmetry concepts in physics for a lay readership. After all, in 1974, Lee was able to persuade Mao Tse-tung that symmetry and order had a place in physics, if not in society. □

FOR MOST people, the term symmetry evokes only a geometric property of certain spatial patterns: that of being unchanged by a reflection in a line or a plane, or by rotations through certain angles about an axis. More elaborate forms of symmetry involve repetitions of a basic motif, as in wallpaper patterns or tiling. In all these situations, symmetry is an essentially static concept. It, therefore, comes as a surprise to discover that symmetry also has a role in the fundamental dynamical laws of physics.

In the Prologue to *Symmetries, Asymmetries, and the World of Particles*, T. D. Lee recalls how Chairman Mao asked him, in 1974, to explain why symmetry should be of importance in physics. Mao, whose philosophy emphasised dynamical change in nature, as well as in human societies, was puzzled that such a static concept could have any dynamical role. Lee recounts how a simple demonstration with a pencil moving to and fro on a pad sufficed to show him how symmetry could be an attribute of a process evolving in time.

The main part of the book consists of two public lectures: "Symmetries and Asymmetries" and "The World of Particles". Lee delivered them recently at the University of Washington, Seattle. Lee shared the 1957 Nobel Prize for Physics with

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THIS attractive slim volume contains the homage of two great men of physics to Paul Dirac, one of the finest and most creative physicists of this century, or indeed of all time. Alas, one of the authors, Richard Feynman, has just died, but his contribution to this collection represents a fitting tribute to both Dirac and himself.

Feynman's lecture is entitled "The reason for antiparticles". It was Dirac who first predicted the existence of antimatter from his equation, and Feynman who gave us the rules that enabled us to calculate quantum amplitudes for processes involving the creation or annihilation of particles.

The second lecture in this collection is by Steven Weinberg and is challengingly entitled "Towards the final laws of physics". Weinberg, who, with Sheldon Glashow and Abdus Salam, won the Nobel prize for his work on the unification of the weak and electromagnetic forces, takes a look into the future, and speculates on how Einstein's theory of gravitation will finally be reconciled with quantum theory.

Before starting, I must confess that Feynman was my hero in physics, not only for his unique style of doing physics but also because of his intolerance of pomposity, and dislike of "snowjobs"—people who try deliberately to baffle using impressive-sounding but content-free jargon! We betide any seminar speaker who came to the California Institute of Technology and tried to bluster their way through a talk with a forest of fine phrases. Feynman's relentless questioning would soon reveal whether there was any physics there.

Feynman begins his lecture by revealing that the reason he had to accept this invitation was that Dirac had always been his physics hero. Dirac had the courage simply to guess at the form of an equation and, afterwards, try to interpret the physics. In the lecture, Feynman concentrates on two topics very much bound up with Dirac's equation. First, why there are antiparticles, and secondly, the connection between spin and statistics.

Dirac was the first to wed quantum mechanics to relativity. After resolving the confusion over negative energy states, it became clear to him that the key ingredient in this marriage was not spin but the existence of antiparticles. This is Feynman's starting point: he tries to explain why antiparticles are necessary when you try to put quantum mechanics together with relativity.

A tribute to Paul Dirac

Elementary Particles and the Laws of Physics
by Richard Feynman and Steven Weinberg,
Cambridge UP, pp 110, £7.95

Tony Hey



Man of many parts: Feynman served on the shuttle inquiry, hence his meeting with Reagan. Here, he lectures on antiparticles

Merging quantum mechanics with relativity in the framework of relativistic quantum field theory, axiomatic field theorists are able to derive in the axiomatic way a number of very fundamental results concerning antiparticles, the spin-statistics relation, and so on. Feynman's lecture course "arose from the premise that such basic and fundamental results ought to be derivable in a way transparent enough so that one understands why they are true. It was stimulated by a suggestion of Roger Dasher that the three-volume *Lectures on Physics* be followed by a fourth one on relativistic quantum mechanics, starting with the question 'Why are there antiparticles?'

The actual content of Feynman's lecture is, as ever, stimulating and rewarding reading, and gives a treatment of these topics that can certainly not be found anywhere else. I suspect, however, that the "average" physics undergraduate will find it rather hard-going. But Feynman does not take refuge in elegant and powerful mathematics. Rather, he goes back to the "nuts and bolts" of relativistic quantum mechanics—what he calls Maxwell's "gear wheels"—which of course no one knows better than Feynman, and puts them together in his inimitable way to show that "one man's virtual particle is another man's virtual antiparticle".

In the second part of his

lecture, Feynman attempts to shed some light on the origin of the Pauli exclusion principle and the spin-statistics relation—something for which, in the famous Feynman Lectures, he apologises for not being able to explain simply.

There is a lot of material here, ranging from a demonstration of how 360-degree rotations can change things to proving that time reversal applied twice to a spin-1/2 state gives a factor -1, the same as a 360-degree rotation. Feynman brings the lecture to a climax with a discussion of Dirac magnetic monopoles.

There is a post-lecture postscript in which Feynman gives a yet more direct demonstration of the connection between spin

and statistics. This involves showing that an exchange of two particles implies a 360-degree rotation of one particle frame with respect to the other. These things are not so obvious to mere mortals and on this particular point I had a private lesson. Sitting in the sunshine in the garden of his house in Altadena one summer, Feynman patiently demonstrated this to me, using the belt from his trousers! This is illustrated in the book. But is not so memorable.

Weinberg's lecture is very different, and surprised me by requiring much less effort to read. After explaining what he means and does not mean by "final underlying laws" of physics, Weinberg begins the lecture proper with a "two-minute course in quantum mechanics" for any strays in the audience.

Symmetries, QED and the dimensional analysis of physical quantities and coupling constants are then elegantly and clearly explained as groundwork for a discussion of the standard model of particle physics, in which Weinberg, of course, played a key role. The standard model agrees with a vast range of experimental data but requires parameters to be chosen "just so". It also ignores gravity. It is regarded by most theoretical physicists as only a low-energy phenomenological approximation to a much deeper and underlying field theory.

Weinberg then leads us gently on to the ideas and goals of string theory, and succeeds in giving a fascinating flavour of this mathematically complex subject. I cannot help feeling that a theory in which all the masses of all the presently known particles are zero without some, as yet unspecified, symmetry-breaking mechanism, and which predicts new effects at mass scales we will never conceivably be able to reach, must be somewhat far-fetched. However, Weinberg produces a beautiful Dirac anecdote to prevent such muttonous backsliding. At a public lecture, Dirac, to the intense discomfort of many of the physics faculty present, said that students of physics shouldn't worry too much about what the equations of physics mean, but only about the beauty of the equations.

In conclusion, Cambridge University Press are to be congratulated on making these two excellent and thought-provoking lectures available. *Elementary Particles and the Laws of Physics* is a book that all physicists will be pleased to have, on their shelves, and one that will surely stimulate aspiring theoretical physicists. □



Weinberg: key role in developing the standard model of particles

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CLOUR is, first and foremost, a subjective phenomenon. Everyone agrees that grass is green, but there is no way of knowing whether the sensation of green that someone else experiences is the same as that you experience. Objectively, of course, one can feed light into a spectrophotometer, which is a machine for performing spectral (or Fourier) analysis, and obtain a unique and repeatable result. But while there is virtually an infinity of possible spectral profiles, how the eye and brain respond to each is a highly complex physiological question.

Scientists have long known that the same colour sensation can be created by the superposition of different combinations of pure (quasi-monochromatic) sources. The eye perceives pure red plus pure green, for example, as yellow, but the spectrophotometer will of course reveal that the observer is being "fooled". The rules of colour addition can be approximately quantified in the so-called chromaticity diagram, which reflects the physiology of the normal eye. Most textbooks on optics discuss this.

In a celebrated series of experiments, Isaac Newton (1642-1727) studied the spectrum created as sunlight passes through a prism. He concluded that white light was made up of rays of different colours which were refracted differently by the prism. Goethe (1749-1832), whose background was that of a poet and writer rather than of a scientist, took violent issue with Newton and his followers, waging an aggressive war of words against them in a series of books and papers, written between 1790 and 1810. At the time, Newton had been in his grave for more than half a century.

Repeating Newton's experiments in exhaustive detail, Goethe became convinced that because coloured spectra were visible only when there was a boundary between light and dark in the field of view, the colours must in some sense be created by the boundaries and were not present as components in the initial white light source as Newton claimed. So obvious did Goethe feel Newton's error that he indulged

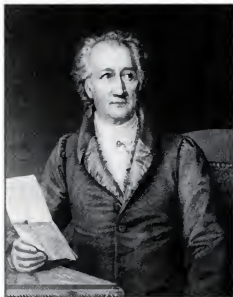
A strange theory of light

Goethe contra Newton
by Dennis Sepper, Cambridge UP, pp 222, £27.50

Geoffrey New

in the most contentious polemic, implying that the views of Newton and his many contemporary followers were not

Newton ("and was on solid ground [in pointing up] serious factual and methodological shortcomings in the work of



Mary Evans



Mary Evans

Rival theorists: Goethe (left) maintained that because colours were visible only when there was a boundary between light and dark, colours must be "created" by boundaries. Newton, of course, concluded that colours were simply components of white light

worthy of serious consideration.

The battle between Goethe and his opponents has become notorious in the history of science, and the verdict of history has always been that Goethe was profoundly wrong. Goethe himself never conceded defeat and ultimately took solace from the emergence of the wave theory of light, which he interpreted as vindicating his position.

In *Goethe contra Newton*, Dennis Sepper seeks to re-evaluate the episode. He reviews Goethe's background, Newton's prism experiment, and Goethe's own experiments that led him to take issue with Newton's conclusion. Naturally, there is extensive discussion of Goethe's writing on colour, and exhaustive coverage of the minutiae of the arguments and counter-arguments. Although the book is nicely presented and written in a very easy-to-read style, these features cannot compensate for what are in my opinion fundamental defects.

What is wrong? First, I looked in vain for a clear summary of Goethe's position, and a distillation of his arguments. If part of Sepper's intention is to show that Goethe was not quite as wrong as most people thought (that Goethe had an "amplified" conception of science than

Newton"), identification of the key issues would seem to be essential. A clear point that might for instance be made is that whereas Newton thought that white light contained all the colours and that a prism merely separated them, Goethe believed in a so-called "modificationist" view of light in which the prism actually created the colours. If this is the case, then one could argue that Goethe's disagreement with Newton was really one of semantics. Whereas there might be a basis for argument if light consisted of corpuscles, this is hardly the case if the wave theory is accepted. Whether white light contains its Fourier components or whether these are created by the prism of spectrophotometer is more a question of words than of principles.

Secondly, even if you accept that the root of the Goethe-Newton controversy lies more in semantics than in reality, Sepper's book does nothing for Goethe's reputation as a scientist and, therefore, fails in one of its apparent aims. Whether he was actually right or wrong, Sepper succeeds only in convincing the reader that Goethe was grossly prejudiced in his approach to scientific problems, and that his opinions were quite out of proportion.

We now know that Newton's theory of light was certainly incorrect in some respects, but this does nothing to diminish our fundamental respect for him as one of the greatest scientists of all time. It would surely do Goethe's reputation a greater service to concentrate on his indisputable strengths in other fields, rather than dwell on his weaknesses in the realms of science.

Thirdly, Sepper makes no attempt to summarise the rudiments of colour science, which is surely vital background material for a work of this type. Nowhere does Sepper explain any of the basic ideas outlined in the first paragraph of this review. He mentions spectral analysis a couple of times, but does not explain it; the word "Fourier" does not appear in the index at all and only once in the text. Although he discusses Newton's colour circle, he does not treat the modern chromaticity diagram and the simple principles of colour vision. And although the word physiology crops up occasionally, the importance of the retina in the perception of colour is not highlighted.

Extraordinarily, Sepper spends just 10 lines talking about the wave and corpuscular theories of light, a crowning example of how matters that are clearly essential background to the subject are virtually ignored. How can Sepper hope to evaluate a historical argument about colour while neglecting to say anything significant about the current understanding of light?

While some scientists could well find something of interest in the issues themselves if these were properly explained, they are unlikely to find this book a satisfactory vehicle. Ironically, I have to conclude that *Goethe contra Newton* is not only about a gulf between the sciences and the humanities in the past, but the divide in the present.

To be rated a success, a book of this kind must bridge the gap, and the author must be seen to be a master of the science as well as of the history. Historians of science may of course feel quite differently, and to that extent it may be Sepper's misfortune that *New Scientist* has reviewed this work. □



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Technology in the marketplace

Business for Engineers

by Brian Twiss, *Institute of Electrical Engineers*, pp 209, £24

Antony Anderson

THE VC 10 jet airliner was designed to operate from short runways at high altitude in Africa. This was to give it a competitive advantage on long-haul routes. However, by the time the VC 10 came into service, African runways had been lengthened, making it possible for a more economic competitor, the Boeing 707, to exploit the market. As a

good of the organisation.

Business for Engineers is a book about engineering decisions and how they must reflect the needs of business. Its author, Brian Twiss, aims to give the reader an understanding of the people with whom he or she must cooperate in order to further the business as a whole.

Twiss raises a number of issues the engineer must under-



Failure of foresight: the VC10, designed for short runways in Africa, lost out when runways got longer

consequence, the VC 10 was not a great commercial success. Had the designers anticipated the extension of runways, and considered the transport system as a whole, they would have been able to relax the specification of the VC 10. Likely as not, the aircraft would have given the 707 a run for its money.

National Cash Register, the market leaders in electro-mechanical equipment, recognised the threat from the electronic cash register. It did not, however, think that there was an urgent need to meet that threat. The company failed to anticipate the increase in the market share of electronic cash registers, from 10 per cent to 90 per cent between 1972 and 1976. It had to write off a \$140-million investment in electro-mechanical plant after one year of operation, and make 20 000 workers redundant. In the process of launching an electronic product, the company nearly went bankrupt.

These and many other examples illustrate how important it is for engineers to understand business strategy: how to grasp the long-term threats and opportunities presented by technology, and how to use such knowledge for the

stand if he or she is to succeed in their career. He discusses important concepts, such as the relationship between the 50-year, or long-wave, economic cycle and technological innovation. He introduces the reader to techniques such as market forecasting. He provides a starting point from which the engineer can expand knowledge.

Business for Engineers is readable, and Twiss succeeds admirably in putting across the need for engineers to enlarge their horizons and become effective advocates of change in industry. His thesis is that engineers must play an active part in the affairs of the business and must understand its needs. Engineers must market their proposals and persuade the recipients of their validity. He sees the engineer as exercising an active and constructive role within the organisation, rather than a passive one.

This book should be on the reading list of students and aspiring engineers and executives, because it makes a real attempt to break down the barriers between disciplines and focuses attention on the primary business issues. It represents a useful contribution to the revival of the British engineering industry. □

BOOKS CAN fascinate for a great variety of reasons, but *The Evolution of Individuality*, by Leo Buss, falls into a rare category. Its theme is one of the most important problems in contemporary biology. It asks all the right questions. But, in my opinion, it manages to come up with nearly all the wrong answers. This is due not so much to its factual inconsistencies as to its cognitive style of inquiry, which tends to close the door on further investigation into the important issues which it raises. So this book, written in a very attractive style by an expert in the field, is fascinating because of the way it reveals a particular mind-set in biology.

Buss's objective was to reintegrate development with evolution, studies which were split asunder in the late 19th century. The split was an unintended consequence of Weismann's conceptual scheme. This gave Darwinism a theory of inheritance consistent with natural selection, something Darwin himself had failed to do. It set the scene for 20th-century biology, which has constructed a complete theory of inheritance and evolution, the "modern synthesis," within which development plays no part. This is an odd situation, because evolution is, in fact, based on reproduction, of which development is a major aspect.

Weismann proposed that the bit of the organism that is involved in inheritance, the germ cells, contain information in the genome (the "genetic program") which directs the development of the egg into an adult, but is insulated from any reciprocal influence from the organism. Development, therefore, has no influence on the genome, so it can be ignored by those interested in evolution; all that counts is the organism's fitness. This is one of the foundation stones of the modern synthesis.

Buss, a developmental biologist, starts off by examining Weismann's proposal, and finds it wanting. In his words: "A synthetic theory came into being that was and is at variance with known developmental patterns." The vast majority of species fail to conform to the assumptions of the contemporary theory. Having scored a direct hit on the modern synthesis, Buss chooses the option of patching up the damage. "The synthetic theory cannot be incorrect, it can only be incomplete." Buss undertakes to show how natural selection, acting on inherited variants, can explain the major phenomena of development.

Natural selection and development

The Evolution of Individuality

by Leo Buss, Princeton UP, pp 201, £25.10 hbk, £8.10 pbk

Brian Goodwin

The trick is to identify the units of selection involved. He argues that these aren't individual organisms until late in the evolution of animals, when individuality arises (hence the title of Buss's book); they are cells interacting with one another to produce multicellular organisms. So the whole book is about ways in which cells might have been selected to do interesting things that produced complex organisms.

To illustrate both the pattern of Buss's argument and what I regard as the rational alternative, let us take a look at his first example. One of the most basic events in the development of most animals is gastrulation. In this process, a single-layered hollow ball of cells turns itself into a multi-layered structure. The cells in the different layers then interact in various ways to produce the components of the different tissues and organs that gradually emerge as development proceeds. Buss notes that these cells can either have cilia or they can divide, not both. Now, in constructing a scenario of natural selection, it is usual to say what the problem is which natural selection solves.

According to Buss, it is easy to imagine how cells can come together to form a hollow ball, but they then face a problem. If they are going to survive, they must be able to swim about, and so they need to be ciliated. But if they develop cilia, they can't divide. So the hollow ball is stuck with a conundrum. How does it solve it? It makes a gastrula! The surface cells become ciliated. Some cells move into the interior of the ball, away from the surface, where they can divide away happily and make a more complex structure. These more complex forms are assumed to have an adaptive advantage over the simple ciliated balls that failed to solve the problem, and so the whole of animal development is launched on the path of increasing complexity.

How do we know that these more complex organisms had an advantage? Because they are all around us. Then simple ciliated balls should have been eliminated in the struggle. But these ciliated balls, colonial organisms, are still doing perfectly well. Organisms that fail to develop ciliated balls should also have been eliminated by those that solved the

gastrulation problem correctly. But sponges develop balls of cells that aren't ciliated, which nevertheless gastrulate, and they, too, are doing fine.

The trouble with "explanations" by natural selection is that the historical scenarios proposed are untestable because we cannot reconstruct the conditions that prevailed. And they fail to explain the forces within the organism that generate the structure on which natural selection is assumed to operate. They tend to close the door to further inquiry, which is not scientifically healthy.

What is the alternative? It was provided several years ago by a biologist called Willmer. Buss doesn't refer to him in his book. What Willmer noticed is that a number of unicellular organisms have the property that, if they are in salt solutions, they are amoeboid, but if they are in fresh water, they develop flagellae and swim about. So it's natural for these cells to exist in either form, depending on their environment.

Suppose such cells come together and formed a hollow ball. The pre-Cambrian oceans, where these early forms lived, were fairly fresh, so cells on the outside of the ball would be flagellated (or ciliated). But inside, the salt concentration would be higher because cells pump salt across their boundaries. Any cells finding themselves in this space would tend to become amoeboid, in which state they divide. Hence the gastrula. Notice that this explanation doesn't invoke natural selection to "solve" a "problem". The gastrula arises because of what cells do naturally, spontaneously, based on their physiology, biochemistry and biophysics.

Every example in *The Evolution of Individuality* can be subjected to this type of critique. Buss always invents selective scenarios, problems to be solved, and possible solutions which are usually untestable and often fail to accord with what evidence there is. Because his units of selection are cells, these are in conflict with one another in the developing embryo, struggling to reproduce more successfully, so they must be controlled to get a developmental process that generates an organism.

One of his proposals for the source of this control is maternal authority, substances secreted into the eggs by the mother to

direct cell behaviour in the embryo. A prediction is that developing embryos without this "mosaic" strategy should be more subject to runaway cell division, that is to a form of cancer. I know of no evidence.

Buss also discusses other methods of control, such as one type of cell inducing another to cease dividing and to differentiate. He raises this inhibitory property of induction to a developmental principle. But there are opposite types of interaction in which one type of cell induces other cells to divide. There are many examples of this kind in the book, involving the multifarious levels of developmental control, all of which Buss discusses in terms of competitive cell interactions and mutual selections.

Does the selective scenario add to our understanding of developmental mechanisms? How does it explain these? What research programme does it lead to? Buss admits that "a precise phylogenetic reconstruction of each interaction between variant cell lineages... is quite impossible at present."

Why not, instead, pursue the path of exact science, study the actual properties of present cells and embryos, and look for the principles that underlie their generative diversity as direct consequences of these properties, as in Willmer's gastrula. We may then understand evolution as those processes that come naturally and inevitably from basic generative principles. Organisms of different form are then natural kinds, the high probability states of biological order. Of course, these states must be dynamically stable: life cycles must be complete for organisms to survive. But let us move beyond the limitations of natural selection as an explanatory principle in biology and attempt to understand the real generative causes of development and evolution. □

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A legendary physicist

Discovering Alvarez

edited by W. Peter Trower, University of Chicago Press,
pp 272, £29.95

William Galbraith

THIS IS A very impressive selection of scientific papers, taken from the published works of Luis Alvarez. It also includes comments and reminiscences of colleagues and students on the work and the man. *Discovering Alvarez* is a tribute to one of this century's giants of physics. It highlights the innate intuition, vigour, inquisitiveness and, above all, intelligence of Alvarez, a man who carried out scientific projects and overcame problems over a period of more than 50 years.

I first discovered Luie, as he was called, in 1957, when I was at Berkeley. He was, by then, quite a legend, and his knowledge and enthusiasm for physics, coupled with his ability to see and drive towards a goal, was something to infect all those around him.

What gave rise to Alvarez's pre-eminent position in physics is revealed in his early publications. He paid particular attention to classical physics in measuring the wavelength of light by diffraction off a gramophone record; he discovered, with A. H. Compton, the east-west effect in cosmic rays; and he worked in the field of K

capture by nuclei.

By 1940, Alvarez had become involved in separating ²³⁵U using the 60-inch cyclotron at Berkeley as a mass spectrometer. He had worked with Bloch on measuring the magnetic moment of the neutron (a classic paper); scattered neutrons in ortho- and para-hydrogen; prepared, with Wiens, mercury-198 by bombarding gold with neutrons derived from a cyclotron; and he had accelerated heavy ions in a cyclotron.

The legend of Alvarez developed in the war years, a period which Lawrence Johnston records well. Alvarez worked on radar at the Radiation Laboratory at the Massachusetts Institute of Technology, originating, among other things, the blind-landing system, GCA. This was a crucial development and, for it, he received the US Medal for Merit and the Collier Trophy of the National Aeronautical Association. Not only did Alvarez work on the nuclear bomb at Los Alamos but he accompanied it to Japan in a following plane. This was to measure its yield in kilotons from observations of blast pressure waves.

Peace brought Alvarez back to

It all started with the pion

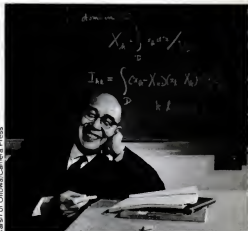
40 Years of Particle Physics

edited by B. Foster and P. Fowler, Adam Hilger, pp 261, £30

Frank Close

IN 1935, Hideki Yukawa, then a young and obscure theoretical physicist at the University of Osaka, published a fundamental paper which proposed that heavy particles transmit the short-range forces binding the atomic nucleus. He pointed out that these particles would not be observed in nuclear transformations, because the energy needed for their creation was not then available.

The experimental demonstration that these particles exist – now called pi-mesons, or pions for short – came a dozen years later. In 1947, Cecil Powell's team at Bristol discovered the electrically charged pion in emulsion



Hideki Yukawa: predicted the existence of the pion 12 years before its discovery

images of cosmic rays.

This confirmed Yukawa's theory of the nuclear force. But no one had anticipated the discovery, that same year, of the first of the family of "strange

Berkeley, and the radar and nuclear bomb legends came with him. Panofsky recounts in his contribution the background to the building of the proton linear accelerator at Berkeley. The account precedes another classic paper, which Alvarez published later in 1955, on this great team effort.

Alvarez's magnum opus, however, must surely be the building of the 72-inch hydrogen bubble chamber at Berkeley and development of the techniques of data analysis, including automatic scanning and digitising of tracks in photographs. A review of all this work is Alvarez's Nobel prize lecture in 1968. It underlines Berkeley's pre-eminence at that time in discovering many new particle states.

Because many Europeans worked at Berkeley in those years, the work set the scale of things to come for particle physics both in the US and Europe. In retrospect, it was possibly the best \$2.5 million the US ever spent on the pursuit of pure science.

The legend continues to the present day. When researchers observed the catalysis of nuclear reactions by muons, it was a delightful spin-off from particle

Natural "X-ray": Alvarez searched for hidden chambers in a pyramid by observing how cosmic rays were absorbed



physics in a bubble chamber, and an object lesson to students to keep their eyes open and ask questions.

particles". Here, was one of the first indications that the matter of the Universe is much richer than previous experience had suggested.

On Earth, restricted to low energies, physicists had discerned atoms made of electrons, protons and neutrons. The energies of the cosmic rays brought Yukawa's pion, and much more besides. Soon the high-energy accelerators, reproducing the cosmic radiation to order and with intensity far greater than the natural variety, enabled controlled experimentation. Today, we can recreate the nuclear processes of the stars, and even simulate the first moments of creation in laboratory experiments.

The year 1947 may be regarded as the birth of modern high-energy physics. It began in Manchester and Bristol. British science, building on the traditions of J. J. Thomson at Cambridge and Ernest Rutherford, at Cambridge and Manchester, had made another epochal contribution to human understanding.

Forty years later, many of the one-time young heroes met

with their modern successors, researchers who are continuing to win international acclaim in this fundamental field, in spite of ever increasing difficulties. The three-day meeting at Bristol University in July 1987 celebrated the anniversary, reviewed how understanding has deepened in the intervening decades and produced the proceedings *40 Years of Particle Physics*.

There is much here to interest the student of history. There are talks by Fowler, Rochester and Butler on the discoveries. Conversi and Kemmer paint vivid pictures of the years leading up to the discoveries, and describe the puzzles that engrossed the scientists of the time.

The pion was discovered by means of emulsion techniques which are still used today. You can read about how the early emulsions were made, and of the early work done with them. You can also learn how they are still being used to study the recently discovered charmed and beauty particles.

Dalitz reviews the role of the pion in particle physics today—

Discovering Alvarez covers the search for the elusive magnetic monopole. Eberhard tells us about one such attempt that used 8 kilograms of lunar rocks, retrieved by NASA. Researchers thought monopoles might be embedded in the lunar material. If they were, however, they failed to reveal themselves.

Alvarez gives his own account of his search for chambers in Chephren's Pyramid. He had the idea to measure the absorption of cosmic ray muons at ground level by the pyramid. He

and it is a fascinating beast, too. Mention the pion to a group of theoretical physicists and you will stir a controversy. For some, it is made of quarks and is too low in mass compared with theory. For others, it is the Goldstone boson of the breakdown of chiral symmetry (and, thereby, too heavy). Physicists use pions as probes of more esoteric phenomena and attempt to discover the details of their inner structure.

What was especially pleasing to me in this book was the verbatim reporting of the discussion session that followed each talk. History comes alive as various participants recall things, sometimes the same, other times differently. Here, you can find what, at least in R. M. Payne's memory, is the etymology of pion and muon; why it was that Butler chose the Pic du Midi rather than the Jungfraujoch for the cloud chamber experiments in 1950; and several admissions of people that they simply couldn't remember this or that about a particular event. Such confessions make the record alive, and delimit what the record can ever

saw no abnormalities in absorption, however. These would have indicated that hidden chambers existed.

The remainder of the selection in *Discovering Alvarez* covers a quark search using a Berkeley cyclotron, the development of variable-focus lenses, and a possible explanation for the extinction of dinosaurs. A diversion involved Alvarez in the analysis of film frames taken at the time of the assassination of President Kennedy.

Finally, underlining the ongoing nature of the legend, there is an account of one out of many patents held by Alvarez. This one is entitled "Dead Reckoning Range-Finding Device for Cart (1984). For golf cart with computer output showing distance to the green". If ever anyone knew the "distance to the green", it was Luis.

Discovering Alvarez is a very important contribution to the history of science. It should be read by a broad age range of physicists, engineers and other scientists who wish to be pleasantly informed on what it is like to be Alvarez, and to feel a whirlwind of life, ideas and physics. You might even find yourself getting a new idea, too, as a result. □

show. Historical researchers should note a photo of the first sighting of the decay of a Ψ -particle purporting to be on the 4 July 1950. This may lead to a reassessment of history, bringing the Ψ discovery in advance of those of other strange particles. The documented version is that the Ψ was discovered a full year after this date. Thinking I had unearthed a footnote to history I checked further. As the police are wont to say, "our investigations are still in progress". But Butler confirms that the date is indeed correct. This is an interesting delight in what is a most stimulating book.

And that is what makes researching history so fascinating—little bits here and there which gradually meld together, not always consistently, different memories, opinions and perceptions. *40 Years of Particle Physics*, and in particular the verbatim discussions, will be an essential element in anyone's library if they want to have a record of the birth of one of the most exciting adventures in science. □

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The ever-growing greenhouse effect

Recent Climatic Change

edited by Stanley Gregory, Belhaven Press*, pp 326, £33

John Gribbin

CLIMATIC change is becoming a hot topic of scientific debate. Witness the speed at which this volume has got into print. *Recent Climatic Change* contains the papers presented at a symposium held at the University of Sheffield in August 1987. The symposium, which brought together climatologists from a broad range of disciplines, focused on the implications of present and future climatic changes for society.

It is surely another sign of the times that the first chapter is on "Modelling the climatic response to greenhouse gases". Mention climatic change in 1988, and the next term every-

surface temperatures going back to the middle of the 19th century, to those of Sahel data I have already mentioned.

Most of us lesser mortals, however, are primarily interested in what all this means for the future of climate and of ourselves. The picture that emerges from this volume is of an ocean-atmosphere system undergoing large and possibly unprecedented changes, almost certainly as a result of human activities.

Barrie Pittock, of the CSIRO, Mordialloc, Australia, concludes that "it is highly probable that, over the next several decades, climatic changes of an



one expects to hear is "the greenhouse effect".

Global warming, however, is far from being either the only, or the chief, focus of attention in this book. On the global scale, we are treated to discussions of the links between volcanic activity and climate and large-scale fluctuations in precipitation. At a regional level, various contributors discuss changes in wind and weather across Europe, drought in the Sahel (and possible links with sea surface temperature), the implications of the events known as El Niño for countries around the Pacific, and much more besides. Yet, at the end of the book the original theme is taken up once again, with a discussion of "The greenhouse effect and future climatic change".

Specialists will probably be particularly interested in the background data. It ranges from a description of the way the British Meteorological Office has established a data set of sea

unprecedented magnitude in human history will take place. These will have numerous and important consequences at a regional level. We can either wait to see what happens and react as best we can, or we can try to anticipate the effects and plan the best strategy to maximise the gains and minimise the losses.

It will be at least a small step along the more desirable of these two paths if *Recent Climatic Change* is widely read by geographers, engineers, agricultural scientists, and, of course, politicians. It is not the definitive statement on climatic change, and its coverage reflects only the interests of the groups that happened to be assembled in Sheffield last summer. Nor is it a particularly scintillating read. But it is full of information which has a direct and profound relevance to the kind of world we will soon be living in. □

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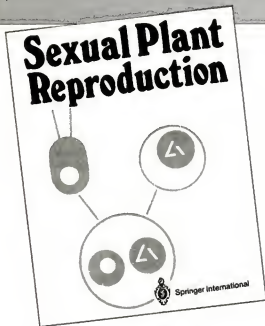
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SAMUEL Warren Carey, emeritus professor of geology at the University of Tasmania, played a remarkable role in the transition from continental drift to plate tectonics. In the early 1950s, at a time when continental drift was as fashionable as Communism in the US, Carey was one of the very few champions of continental drift, bellowing his enthusiasm from his remote antipodean island.

Carey was the first to recognise that the human scale of geological observation was an order of magnitude too small to understand the true scale of planetary tectonics. He saw that all around the ocean-margins the landmasses had become torn apart.

Overwhelmed by this evidence of extension, Carey proposed that the whole planet must be expanding at a rate of several centimetres a year (but strangely only over the past 5 per cent of Earth history). A number of important Earth scientists, including John Tuzo Wilson, briefly flirted with Carey's idea of Earth expansion at the end of the 1950s. Like many whole-

Geological cul de sac

Theories of the Earth and the Universe
by S. Warren Carey, Stanford UP, pp 413, \$45

Robert Muir Wood

Earth theories before it, the expanding Earth became a historical cul de sac.

In the early 1960s, observations of large earthquakes around the Pacific (persistently ignored by Carey) showed that the cold, old ocean crust was sinking beneath the continental margins. At these subduction zones, ocean crust was being consumed as fast as it was being created in mid-ocean spreading ridges. Thus was born the theory of global plate tectonics.

For a period of almost a decade in the 1950s, Carey held the baton of innovation in the relay race of whole-Earth theories. Others then took that baton, developed it, passed it on again as a global team performance in the great arena of modern Earth sciences.

Meanwhile, Carey, confirmed in his role as a heretic, refused to modify his theory to accommo-

date new observations. For Carey never accepted subduction.

In 1977, Carey published a book on his 1950s' theory of the expanding Earth. *Theories of the Earth and Universe* is little more than a new edition of that work. It begins with a potted history of Earth investigators since Aristotle. Carey has assembled this to show how the established view has so often been wrong, and the brilliant outsider mocked: from Pythagoras, Copernicus, Hutton, Darwin, Wegener to Carey.

The analogy is flawed: Earth expansion is not condemned by an older, conservative establishment. It is seen as a theory of the 1950s, which had its moment of triumph from 1957 to 1962 and was abandoned in the 1960s by younger researchers as new observations were made.

In his indifference to reason,

and his pursuance of the *idée fixe*, Carey has taken on the mantle of Immanuel Velikovsky. As with Velikovsky, Carey writes persuasively, and a credulous reader would probably conclude that Carey is a misunderstood genius, and that the Earth sciences establishment a tyranny worse than that of Stalin's.

The only real merit to the book is a brief diversion into autobiography. For Carey was an important and influential figure and had an interesting early field career in Papua New Guinea, a place where Dutch geologists once thought that continental drift was self-evident.

Fecund with (admittedly 30-year-old) imagination, starved of scientific rigour, freed from the need for any supporting documentation, the book, in the manner of pseudoscience, has not one single reference outside the works of Carey. The presentation of archaic theories of the 1950s as though they are the latest scientific intelligence is a curious venture for a once scholarly publishing house. □

Distant lights

High Redshift and Primeval Galaxies
edited by B. Bergeron, D. Kunth and B. Rocca-Volmerange,
Editions Frontières*, pp 526, FF410, \$63

Nigel Henbest

this field, as of July 1987.

The conference was organised by the Institute of Astrophysics in Paris, and the proceedings covers several complementary research efforts. The "sexiest" is the discovery of ever more distant galaxies, using electronic CCD detectors on large telescopes. Already, we can see that these galaxies—whose light left

them in the distant past—are distinctly different from the galaxies around us today. Distant galaxies also leave their traces in the form of absorption lines in the light from quasars, which are even more remote.

A new development is the discovery that some galaxies near to us have apparently just been born from gas clouds that

have hung around since the time of the big bang. Studies of these young galaxies can reveal details of galaxy formation that we can never hope to see in distant galaxies.

High Redshift and Primeval Galaxies will be an invaluable companion to anyone working on extragalactic astronomy, at least until the next generation of telescopes—the Hubble Space Telescope, the Infrared Space Observatory, the European Very Large Telescope in Chile—come along to revise our ideas yet again. □

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A radically different outlook

Developmental Psychology in the USSR
by Jean Valsiner, Harvester, pp 416, £35

David Cohen

SOVIET psychiatry and its abuses hits the headlines; Soviet psychology is rather less well known. One effect of *glasnost* is to make clear our own ignorance of Soviet developments. Jean Valsiner's *Developmental Psychology in the USSR* will do something to remedy those defects.

Ever since the 1917 revolution, the Soviet Union has encouraged psychologists. Good psychologists, the argument went, would help create a good socialist society. Unlike their American colleagues, Soviet psychologists have a defined task: to facilitate the good socialist man.

The notion that people should put social obligations before individual needs is an odd one in the West. In the Soviet Union, Valsiner explains, the idea predates the 1917 Revolution. Catherine the Great demanded *patrinost* from her subjects. *Patrinost* is a mixture of patriotism and duty. Individual sacrifices, which are to be given readily, may be required

for the greater good of the State.

Such an outlook is radically different from that which underlies Western psychology. For nearly 100 years, American psychologists claimed to be pure scientists, and studied the individual in all his or her glory. The behaviourist John B. Watson, inspired by Pavlov, said people should be able to use psychology to maximise their own potential. He urged students to fill in a Balance Sheet of the Self.

To Yankee ears, *patrinost* must sound a strange concept. Yet it clearly is true that political and social forces create the climate in which psychology operates. This emphasis helped alert Soviet psychologists very early in the century to the crucial role social relations played in the development of children. Freud focused on the psychosexual child; Piaget on the logical child. Both views are partial. Though ideology may have forced it on them, the Soviet emphasis on the social child is both true and useful.

One of the merits of this often

interesting, but unwieldy, book is that Valsiner is passionate about his central proposition. You can't divorce psychology from the politics and social forces current at a particular time in a particular society. Because societies are developing—or, at least changing—this makes all psychology developmental. It isn't just so when it studies children.

Valsiner is aware both that his thesis is unorthodox and that we know very little of Soviet science. So he gives extended accounts of certain aspects of Soviet history. He shows how the sciences grew up there in the 19th century. He looks at the state of psychology at the Revolution and the infighting that followed.

Pavlov, the physiologist who conditioned his dogs to salivate to a bell, was king at first. A purely mechanistic psychology suited the Bolsheviks. Lenin gave Pavlov's labs many privileges. The masses might starve but not Pavlov's dogs. After 10 years, though, it became clear that a purely reductionist psychology wasn't enough. Social forces mattered.

Valsiner explained how psychological orthodoxy was changed by unorthodox means. It wasn't new papers or new findings that brought about a shift in the world view. Rather, it was appeals to the party—Stalin was best fitted to judge which psychological approach was truer!—and huge conferences of psychologists. These were convened to decide the new approach. Such conventions gave Pavlov the thumbs down.

I find the scene somewhat appealing. 156 votes for Freud; 143 against. Freud is true. Long live analysis. End of argument.

Nevertheless, voting isn't a very effective means of verifying theories. Valsiner is well aware of this but sometimes he is so fascinated by the strangeness of it all and the need to be fair to the Soviets that he doesn't emphasise dangers of such an approach. Not that Western science never has to cope with political influence. The priori-



Selfless psychology: Catherine the Great expected people to put social obligations before their individual needs

ties of governments today make it easier for some projects to get funded—and harder for others. There are fashions in theories, too. But political influence shouldn't affect what we regard as true, for then truth becomes too contingent.

American psychology has dominated the century, so it's easy to forget the Soviet contribution. Yet the contribution has been great. Pavlov, Vygotsky and Luria were all highly original psychologists whose ideas have been used by everyone in the discipline. Without Pavlov, John B. Watson would have been hard-pressed to make behaviourism into a coherent theory, for it was conditioning that explained how people learnt to behave in the ways that they did.

Vygotsky's studies of children sparked off a major row with Piaget but also inspired a huge amount of work on the social relationships of children and their language. Luria's work established him as a great neuropsychologist. Valsiner offers useful introductions to all their times and work, as well as to lesser "greats".

Valsiner has written a dense, original, well-researched text. Sometimes, he gets bogged down in details but it's worth persevering. We need to understand Soviet psychology better. □

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This week's reviewers

Anthony Anderson is an electrical engineer who lives in Newcastle.

Frank Close is professor of physics at the University of Tennessee, Knoxville.

David Cohen is editor of *Psychology News*. His new book, *Forgotten Millions* (Palden), is a survey of psychiatric care across the world.

William Galbraith is professor of physics at the University of Sheffield. Brian Goodwin is professor of biology at the Open University, Milton Keynes.

Tony Hey is professor of computation at the University of South-

ampton. He is also a physicist.

Peter Higgs is professor of theoretical physics at the University of Edinburgh. He proposed the Higgs particle as a way of breaking the symmetry of the electroweak force.

The Higgs is as yet undiscovered.

Robert Muir Wood is a geology consultant based in Cambridge.

Geoffrey New is professor of nonlinear optics at Imperial College, London.

Dennis Puleston works for the Environmental Defense Fund. When he isn't saving the seven seas, he lives in Brookhaven, New York.

Chance would be a fine thing . . .

Bernard Sansom ponders the flip-side of statistics

THE other day, triggered by an item of news I had just read, I was pondering, as I often do, the meaning of life. My stimulus to meditation, rather than to repeat the potent mantra *om mane padme hum*, is to whistle Colonel Bogie and toss an old penny—I keep one specially for the purpose. Suddenly, I was recalled from the skirts of Nirvana by the fact that I had just tossed six heads in a row. I abstractedly tossed the coin another six times: six tails! Here, surely, was the answer.

I knew that the chances against my tossing six heads were $1:2^6$, or $1:64$, quite difficult; but then to follow that with six tails made it $1:2^{12}$, or $1:4096$, surely virtually impossible. And yet I had just done it!

And then, with a blinding flash, I realised the full extent of my powers. For, whatever the sequence of heads and tails I had tossed, the odds against it would equally have been $1:2^{12}$. Clearly, I was onto something really big. By tossing my penny, say, 120 times, I could achieve something the odds against which were truly astronomical, $1:2^{120}$ or, to put it another way, $1:1.3 \times 10^{36}$. Thus, I was in a position not merely to believe as many as six impossible things before breakfast, but to do six impossible things before breakfast—just by tossing my old penny.

The news that had triggered my meditation was that between 1968 and 1984 there had been no fewer than six cases of childhood leukaemia in the area around Dounreay, whereas the expected number (based on the incidence of leukaemia in Britain as a whole) was only two. Now, having just tossed six heads and six tails one after the other in half a minute, I did not feel that six cases of leukaemia in 16 years was a very remarkable statistic. Moreover, the report itself made it clear that, over that period, the odds against six cases having occurred by chance were only $1:12$. It went on to say that, because the cases had all occurred after 1979, the odds were rather longer, but, in the circumstances, this distinction seemed preciously like splitting hairs.

The report, published by the Committee on Medical Aspects of Radiation in the Environment, will undoubtedly give rise to an enormous amount of distress and inquiry; the committee itself says that the

findings at Dounreay, and similar findings at Sellafield, "warrant a vigorous programme of investigation to explore all possible explanations", and the Scottish health minister has already said that the government will fund detailed case-studies of the young victims and an investigation into radioactivity in household dust in the area.

However, the simple, but nonetheless

would) have been seriously worried. So what is so remarkable about six? Might not the situation be just a little like my tossing six heads in a row? The odds against that were longer than $1:12$, and yet it happened—and I followed it up with six tails! Furthermore, there are very cogent reasons for thinking that the six cases of leukaemia could not have been related to the radiation allegedly escaping from the reprocessing plant at Dounreay.

First, it is well known that there are similar clusters of cases of leukaemia in other areas of the country where there is no suspicious nuclear installation in the vicinity.

When the incidence of the disease is so low, this highly random distribution is surely not surprising. The scattering of a few events, without any certainly known cause, is bound to be highly random, because there is no opportunity for the statistical smoothing produced by large numbers.

It is possible to predict the number of random events only when there are so many of them that we can predict fairly accurately the range between which the numbers might fall. Moreover, we can positively ensure that we observe "odd" distributions simply by dividing the population into sufficiently small groups, and defining the limits of "oddity" sufficiently widely. If, as in the present case, the limits of "oddity" are defined to be $1:12$, then we need only divide the population into 12 sub-populations to be reasonably sure that such an oddity will appear in one of the 12 sub-populations—just as, if we wanted to be reasonably sure of tossing six heads in a row, we need only to toss the coin for 64 lots of six throws.

I suspect that the population being considered around Dounreay is very much less than the 5000 000 or so people who would constitute $1/12$ th of the population of Britain. Thus, in considering such a small population, the country has effectively been divided into many more than 12 sub-populations, with the result that "oddities" with likelihoods much less than $1:12$ should not be unexpected in one or two of them. To take this argument to its logical limit, the probability of any individual child contracting leukaemia is extremely small, but unfortunately that does not prevent some individual children from getting the disease, among them the six from the Dounreay area. The truly



Ian Preece

series, question which needs to be addressed is whether such an apparently trivial statistical anomaly is worth such serious consideration. The fact that the disease itself is so dreadful should not be allowed to affect this judgment.

Let us accept that the expected number of leukaemia cases should have been two. If there had been no cases there would, rightly, have been neither whoops of joy nor portentous disquisitions into the reasons why, just as there had been no investigations during the lead period for leukaemia between 1968 and 1979. If there had been three, or even four, similarly no sensible person surely could (although there might very well have been some who

► insuperable problem is to predict which children will be affected.

Secondly, although it is known that leukaemia is a consequence of excessive radiation, there is no evidence whatever, and the report admits as much, that the Dounreay population has been subjected to any detectable increase in its dose of radiation—above that delivered by natural sources. Within Britain there are wide variations in the radiation doses received by people in different areas, between approximately 1 and 100 millisieverts annually. The high doses occur in granitic areas such as Dartmoor and Aberdeen. There is also an area of granite close enough to Dounreay to cover a substantial proportion of the area within a radius of 15 miles of the reprocessing plant, the area considered by the committee. But if Dounreay's cluster is due to the granite, why does not Aberdeen have a cluster—or does it?

A thorough investigation of whether there is any association between the incidence of childhood leukaemia and the variations in natural radiation dose throughout the country would appear to be a far more worthwhile project than any amount of investigation of the radioactivity of the household dust in Dounreay. The numbers of people in the different categories, and the numbers of cases of leukaemia, might be sufficiently large to allow a more decisive statistical analysis.

So what is the answer to the apparent paradox that, given an old penny, I could do six impossible things before breakfast? It is never difficult to do things which, with hindsight, can be shown to have an almost infinitely remote possibility of happening; the real problem is to be able to predict when they are going to happen. Thus, it would have been far more impressive if I had predicted that I was going to toss six heads in a row. The chance of my prediction being correct would have been exactly the same as the chance of my tossing the six heads, but I would have been doing it in advance. After the series of six heads, that particular run has occurred and it is no longer remarkable—its probability has become 1. But the prediction will always retain whatever low probability is relevant—for example $1:1.3 \times 10^{16}$ for getting a sequence of 120 throws in the correct order.

Similarly, the work of the committee would have been far more impressive and valuable if, taking into consideration the radiation doses to which the people of Dounreay had been subjected, and using the best available information on the dose response relationship between radiation and leukaemia, they had been able to predict that six, rather than two, cases of leukaemia were likely to have occurred in the area between 1968 and 1984. The essence of a sound statistical analysis is that it should be possible to use it to predict the outcome of events, not merely to record an apparently abnormal event.

What the committee has reported appears to me to be no more remarkable or significant than the fact that I tossed six heads in a row. I think I shall go back to whistling Colonel Bogie, toss a few more pennies, and try to understand how it is that the impossible, let alone the slightly improbable, so often happens. □

Good enough to eat?

How did we ever find out, asks Sue Birchmore

IT OCCURRED to me while I was chopping onions. Groping through the fume-induced fog for a tissue, I mused on the surprising number of foodstuffs which fight back in some way. The tear-gas tactics of the onion are legendary, but other vegetables make them seem mild by comparison. A colleague of mine suffered a distressing half hour after touching his face while chopping chillies; the juice of raw peppers is powerful enough to make skin and eyes burn like fury from a single contact.

Hostile foodstuffs abound; horse-radish has effects similar to onions (but an order of magnitude more powerful), pepper provokes sneezing fits, mustard burns the tongue, and, although garlic may be very well for the eater, it subjects people nearby to noxious vapours for hours (even days) afterwards. Curry spices leave those who have not become acclimatised from infancy gasping and perspiring. And there are worse; raw red-kidney beans can cause severe stomach upsets or even kill. Cassava, if I remember correctly from geography lessons, requires peeling, grating, washing and baking to prevent it from poisoning the eater. And in *New Scientist* earlier this month (2 June, p 54) I read of an excellent, highly nutritious native Andean legume, called *tarwi*. Its one drawback is the poisonous alkaloids it contains, which have to be removed by soaking in a stream for a few days.

The point which exercises my mind is this: how did anyone discover that you

Sue Birchmore is a design engineer living in Birmingham.

could eat such unpromising items? I have this picture of an early hunter-gatherer ancestor rooting up an onion during a spot of gathering. She inquisitively peels back the brown skin, tears off a bit of the flesh with her nails, and gives it a sniff. When she recovers from the stinging eyes and running nose, she hurries back to her group.

"Don't eat *that* root!" she warns them. "Just *smelling* it nearly killed me!"

Perhaps desperation accounts for it. A hungry hominid might well reason: "I'm dying of starvation anyway, so I might as well eat this poisonous thing." Finding himself still alive afterwards, naturally he would add it to his list of approved foods, even if it did have distressing side-effects. Later, people would discover that cooking moderated the flavour and removed the sting. But what about the foods which are actually poisonous until treated? How did anyone discover that the beans which made you ill if you ate them raw were fine after soaking in water overnight and then boiling for 20 minutes? You would expect, after an initial encounter, that they would be classified as poison and left severely alone.

Maybe that's it. Maybe they were classed as poisons. An annoyed wife might well sneak some beans which were a known poison into the stew with the idea of doing away with her husband, only to find him in perfect health the next morning because the processing had rendered the poison harmless. Live and learn, thinks the would-be poisoner, and adds the beans to her regular culinary repertoire.

That theory works well enough for foods which need fairly normal cooking routines to make them safe, but it seems unlikely that anyone would go in for soaking in a stream for four days just by chance. It strikes me that such a specialised process implies some deliberate programme of experiment, trying out different processes in an attempt to make potential food edible. Perhaps the results were tested by feeding animals—or captive humans. In any case, it suggests that some ancient peoples came closer to scientific methods than we usually give them credit for.

If there are any experts on prehistoric cookery out there, I'd be glad to know the answer. As for the onions which triggered this whole train of thought, let me leave you with the wisdom of some anonymous graffiti artist: "An apple a day keeps the doctor away—but an onion a day keeps everyone away." □



Some like it hot. But how did they get to like it at all?

Mary Evans

A new plan for Africa

Development agencies should think big, says Norman Adams

THE record of African development in the past few decades has been disappointing. Despite massive overseas aid, poverty and malnutrition are widespread and environmental damage is alarming. Moreover, there is little sign of improvement. Calls for increased aid become louder and, with a few notable exceptions, the region is far from standing on its own feet.

The conventional wisdom is that the high-technology methods by which European agriculture developed are not appropriate for Africa. Most Africans are subsistence farmers and, therefore, it is thought that appropriate techniques must be developed to help them and thus to raise food production. The continued food shortages in countries with huge land resources show that this approach has been unsuccessful. In Swaziland, for example, government policy and the agricultural education system have been geared for 20 years towards helping the small farmer. Despite this, production of maize on small farms appears not to have increased and the country depends increasingly on maize imported from high-technology farms elsewhere.

Policies aimed at development through encouraging small farmers may fail for several reasons. First, they keep too many people on the land. Less than 12 per cent of the population of developed countries is employed in agriculture; the rest are available to produce the goods and services needed for affluence. If, as in many African countries, more than 70 per cent are engaged in agriculture, poverty is unavoidable. To develop, it is essential to eliminate subsistence agriculture and to encourage a market-orientated farming system, employing fewer people.

Secondly, the physical presence of small farmers prevents the development of a modern agricultural sector. In Swaziland, traditional farmers were displaced from some areas and multinationals allowed to use the land to grow sugar cane. The sugar industry is now the mainstay of the economy. It produces more than 40 per cent of the country's exports and thousands of Swazis in it have jobs, decent housing and can shop in well-stocked supermarkets. Its success—and that of large commercial farmers in Zimbabwe—show that modern agriculture is perfectly feasible in Africa.

It would help Swaziland tremendously if the imported maize were replaced by maize grown on commercial farms in the country, where there are plenty of suitable soils. But some traditional communities would have to be relocated to make room for the modern farms and this is often opposed on sociological grounds. Such opposition has no more merit than the arguments of the 19th-century Luddites who smashed textile machinery because they feared it would create unemployment. As long as African agriculture is perceived as a gigantic scheme for relieving unemployment, Africa will go hungry.

Thirdly, small farmers often lack initiative because, if they had initiative,

they would find some more rewarding occupation. I have taught many hundreds of young Africans of above average intelligence and motivation. They are united in their desire to escape from their traditional lifestyle. After living on campus with clean water on tap, electricity and water closets they will not willingly go back to a rural homestead—even one fitted with a solar-powered battery enabling a light bulb and a

organic manure, the soils of another area must be being depleted. It is no more possible to raise soil fertility in an area as a whole by using organic manures alone than it is to design a perpetual motion machine. There is no alternative to a large increase in use of fertilisers if African food production is to increase.

Much of the agriculture instruction at some African universities is oriented towards methods suitable for traditional farmers. As a result, many Africans leave university with neither the technical know-how nor the get-up-and-go attitude needed to succeed in commercial farming. The



Room for improvement. Traditional methods of farming are not necessarily the best

TV set to be run half the evening, and an improved cooking-stove requiring only half the firewood to be headloaded. Traditional communities are losing their best brains and the process is understandable and unstoppable.

Fourthly, traditional farming is an environmental disaster. Most African environmental damage is caused not by the large developments which sometimes attract criticism from the environmentalists but by the remorseless spread of traditional agriculture in response to increases in population. The real damage is being done by the new maize field put on erodible ground, the hectare of forest cleared for small-scale farming, the extra few cattle put onto overgrazed communal land and the bush chopping by the firewood gatherers. It is increasingly being appreciated that development must be sustainable. Traditional agriculture is not sustainable.

Failure to see that small farmers have no future causes much misapplied research work and teaching. For example, because small farmers cannot afford fertilisers, researchers pay great attention to organic manures. Of course organic manures are valuable and every kilogram available should be used. But the nutrients in them are only nutrients already in the system which are being recycled. If the soil fertility of part of an area is increased by using

ability is there, but they do not think big enough because too much of their thinking has been devoted to the problems of traditional farming—a career which none intends to follow.

Development agencies are increasingly emphasising that the private sector must play a greater role in African development. The failure of state-controlled economies has made many African governments less anti-business than hitherto and the prospects for an efficient modern agriculture are improving. Africans have the same needs and aspirations as the rest of humanity and ultimately will develop in the same way as Europeans have, for the same reasons.

Given sound policies, Africa could evolve in a generation into a largely urban and much healthier society, well fed by a small proportion of the population using modern farming methods on a fraction of the area now used for food production. The human and environmental benefits of such a change would be enormous. Too much aid effort at present is devoted to searching for appropriate methods of helping traditional farmers, and has the effect of perpetuating poverty. □

Norman Adams is a soil scientist and a senior lecturer in the crop production department at the University of Swaziland.

The great ecological hijack

It's time the ecologists fought back, says Steve Greenwood

MANY professional ecologists take umbrage when they hear of words from their discipline being usurped by politicians. Personally, I think that it's a good thing, and if we dislike what is being done to our favourite words, then we should step into the political arena and join in the debate.

Ecological concepts have certainly become very popular. Politicians of all parties have realised that a sprinkling of environmental catch phrases in any speech or policy document is bound to bring in the votes. Used with care, such phrases can summon up warm, romantic, cosy rural feelings in the audience while at the same time being totally meaningless. This is a very handy quality and "ecology" now ranks second only to "community" as a potentially priceless non-word.

Despite such abuse, some political thinkers have been attempting to give the politics of ecology real philosophical roots and to develop a realistic programme. For many years, the clarion call of the Greens in Europe was "neither left nor right". However, after a decade of experience, there has now been a split between those who see common ground with socialism and those rejecting any such links. At the same time, many socialists have been look-

ing towards the Greens to rediscover their roots. Many see the old socialist values of cooperation, sharing and egalitarianism there.

In the past couple of months there have been two important meetings in Britain aimed at thrashing out the similarities and differences between the red and green philosophies. The first was held in Oxford and the second in London. At both these meetings, people of various political hues managed to find much common ground, and began to lay the foundations for a potentially popular and fair alternative to the dominant parties. However, one group of people was notable for its absence at these meetings. Trade unionists, teachers, health workers and social workers all managed to make important contributions to the debate on ecology. But where were the ecologists?

Ecologists have had an enormous impact on green politics. Many of the central arguments are based on evidence that they have provided. They discovered the subtle effects of pesticides, air-borne pollutants and nitrates in the ecosystem. These, along with the loss of habitats and the possibilities of long-term climatic change on the world, are all regularly cited by green politicians. Yet professional ecologists are absent when it comes to setting the agenda for change in the next century.

So much valuable work has been carried out by ecologists, and yet it remains half hidden in research reports and papers. Ecologists have a duty to explain the implications of their work to the wider audience. This applies not only to forgotten research findings. Tentative conclusions made by scientists working with small samples are often distilled into simplistic slogans by those seeking to justify their beliefs. It is up

I'M AFRAID WE'RE TOTALLY COMMITTED TO RECYCLING.



to ecologists to point out the half truths.

As well as speaking out on what is known, there is an even greater need to speak out on what might be known if only there were the funding and political will to carry out more ecological research. But there appears to be very little discussion among ecologists about what the priorities for research should be. It is no good complaining that there is not enough funding if we ourselves have no firm idea of what we are setting out to achieve. As a body, ecologists should determine a framework of research priorities with the long-term aim of improving the common good of people and our fellow species. With such a framework, ecologists could then make a vital contribution to the debate on what sort of society we would like to be living in during the next century. If we fail to interest ourselves in the debate then we have only ourselves to blame when we find that our work and our name have been totally and irrevocably hijacked. □

Steve Greenwood researches into biological control.

ENIGMA

No 468

On the town
by Sidney Kravitz

IN THE following addition sum, each letter stands for a different digit from 0 to 9. Find the decoded sum.

EDWARD
WENT
+ TO
LONDON

A £10 book token will be awarded to the sender of the first correct solution opened on Thursday, 14 July. Please send entries to Enigma No 468, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 465, "Alphadividual", was Robert H. Young, of Paisley, Renfrewshire.

Answer to Enigma 465
Alphadividual

1793
53)95080
53
420
371
498
477
210
159
51

A thankless task and seeds of dissent

More comment from Westminster

THISTLE DIARY



Tam Dalyell MP

IPREDICT that, in two years time, the name Polkinghorne will be familiar to every Member of Parliament. I first heard it more than 30 years ago, when my friend Nicholas Kemmer told me about a brilliant young lecturer in mathematical physics in his department at Edinburgh. Since then, John Polkinghorne has been a Cambridge professor, a fellow of the Royal Society, chairman of the Nuclear Physics Board of the Science Research Council, and much else. Now, as Dean of Trinity Hall, he has embarked on an exceedingly tricky assignment—chairing a committee to consider the use of tissues from aborted fetuses.

The committee will comprise Sir Raymond Hoffenberg, president of the Royal College of Physicians, Ian Kennedy,

professor of medical law and ethics at King's College, London, and Sally McIntyre, director of the Medical Research Council's Sociology Unit in Glasgow.

All hell will be let loose in the House of Commons if they reach the conclusion that I think (and hope) they will reach—that a lot of desperately ill long-term patients can be helped. Their terms of reference are: "In the light of recent developments in the field of human tissue transplantation, and other relevant medical research, to review the Report of the Advisory Group on the use of Fetuses and Fetal Material for Research (the "Peel" Report), and in particular to consider whether any modifications or additions should be made to the Recommended Code of Practice in that Report."

A lot of MPs will go spare. They have not yet latched on to the issue. When they do, I hope they will take into account the needs of some of our disabled constituents.

ALONG with various colleagues in the Labour Party, I recently visited the headquarters of the Department of Agriculture

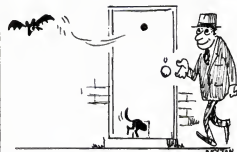
and Fisheries for Scotland at East Craigs. Its work includes seed certification, enforcement of the Seeds Regulations, checking the work of licensed seed testing stations, and advising growers and seed merchants. Now there are plans for privatisation. In case it be thought that I am doffing my hat as a party politician on this issue, readers might like to know that the National Farmers' Union of Scotland, hardly an organisation which is affiliated to the Labour Party, has to say about the proposals:

"The proposals would sacrifice the present official impartiality of the certification systems, relying instead on an astonishing degree of self regulation, which would generate real doubts about the quality of seed, and ultimately the quality of the crop which is produced. This at a time when quality has never been a more important factor in maintaining the industry's competitiveness, in both national and international markets.

"The proposals would not generate any savings—they would simply transfer costs to different sectors of the industry. Small businesses who are not in a position to employ and train additional staff will be particularly badly hit. There would be severe disruptions to the structure of the Scottish seed trade in particular, which has the greater proportion of small independent businesses, who depend on access to impartial official staff, and pay for the service.

"The review team's conclusions are ill-founded, without justification and would result in no savings whatsoever to the taxpayer. They would however drastically weaken the schemes, reduce consumer protection and threaten the competitive position of small businesses, to the detriment of the agricultural industry as a whole."

The issue is likely to cause a sustained parliamentary row.



I RECOMMEND to readers who have followed the saga of the 1981 Wildlife and Countryside Act in this column the newly published booklet, *Bats in Houses*, published for the Fauna and Flora Preservation Society, and written by A. M. Hutson. It describes features of houses that are used by bats as roost sites, and suggests ways in which these can be incorporated into buildings in which bats would be welcome. Remtox Chemicals, who say (I understand with justice) that they use only safe chemicals for timber treatment, have produced the funding for publication. It is available, price 60p, from FFPS, c/o Zoological Society of London, Regent's Park, London NW1 4RY.

AFTER months of deliberation, the 13-nation European Space Agency has finalised the names for the various bits of heavenly hardware it is to build as part of the international space station, planned for the 1990s.

The two main parts of the ESA-designed package, which are to be plugged into the central US core of the station, are a pressurised laboratory and a free-flying spacecraft which will periodically drift away from the main body of the station. These components are to be called Castor and Pollux, after the twins of Roman mythology who also lend their names to well-known stars.

Not a bad bit of christening, you might think, until you try to pronounce Pollux in French—which is fast replacing English as the unofficial language of the European space community. The problem then is that Pollux bears a close phonetic resemblance to a certain English word describing an important part of the male anatomy. The name will doubtless annoy Kenneth Clarke, the British minister responsible for space matters, who has made clear his general disdain for ESA's schemes, and who probably thinks they should all be classified under the title of this particular programme.

THE white shirt, button-down collar and dark business suit have become the uniform of corporate America. So, it is fitting for Feedback to reveal that IBM, the company that virtually invented this outfit and enshrined it in company dress codes, has a computer called YUPPIE. It is a research machine constructed from multiple processing units.

THE handling of hazardous waste is an activity particularly prone to accusations of mismanagement, administrative blunders and even the odd element of corruption.

It seems it can also fall foul of Britain's catch-all Official Secrets Act.

Buried away in the latest annual report from Britain's Hazardous Waste Inspectorate is the following gem.

The Property Services Agency, which looks after government buildings and such places as army camps, is criticised in the report for bad housekeeping. The agency, says the report, failed to check on where a demolition contractor was dumping waste from one of its sites.

The rubbish ended up fly-tipped by the side of a beautiful river in the Lake District. It included a 45-gallon drum of chemicals. The drum was labelled, but unfortunately the labelling was in a Ministry of Defence code. Not unreasonably, the local waste disposal authority wanted to know what was in the drum. So it contacted the Property Services Agency.

The Property Services Agency refused to come clean. The coding, it said, was covered by the Official Secrets Act . . .

FEW who have shared an enclosed space with a bagpiper would dispute the fact that this venerable instrument was not designed for parlour rooms. Some might even venture to say that the instrument and the human ear are not compatible. But now

FEEDBACK

two physicians in the US charge that bagpipes pose a risk to the piper's health.

In no less a journal than the *Archives of Otolaryngology—Head and Neck Surgery*, two physicians report that they measured sound pressure levels during solo performances both indoors and out. In both venues, levels of noise—if we may call bagpiping such—reached 115 decibels in the piper's left auditory canal. National law in the US limits maximum exposure to noise to 105 dB for one hour and 115 dB for 15 minutes.

The authors recommend ear plugs. Perhaps the prudent piper could simply borrow a pair from someone in the audience.

YOU may have seen the scurrilous newspaper stories about plans to return *New Scientist* to a dreadful skyscraper on London's South Bank. A new obstacle stands between us and what the editor refers to as the "Towering Infernal". The masters of our destiny have rightly decided that we deserve some fancy new furniture. Unfortunately, this may be hard to come by. This is because there is a shortage of aluminium in the world today. So the company hired to make our new furniture is worried that, when it comes to our turn on the production lines, we may end up sitting on orange boxes. We have yet to reach war-time desperation, but be prepared for a call in these pages for old saucers and the like. Or maybe we should just start retrieving aluminium from the tapwater.

FEEDBACK doesn't often go in for obituaries, but this week it seems right to make an exception. Jeffrey, the magpie robin, is dead.

For at least 10 years, Jeffrey was the only member of his species on the island of Arde in the Seychelles. The other 29 magpie robins, who belong to one of the rarest species of bird in the world, are on the nearby island of Fregate.

With the death of the loneliest bird on Earth, the future of the magpie robin seems bleak. Jeffrey was the only healthy bird; the condition of the others was poor, possibly as a result of inbreeding. Only the Seychelles authorities know why they did not introduce a few companions from Fregate and, in doing so, help to safeguard the species while they had the chance.

Through a telescope brightly

The outright winner of this year's essay competition, "Through a telescope brightly", organised jointly by *New Scientist*, the British Association Youth Section, the William Herschel Society and the National Maritime Museum, is Jason Lee Semmens, of Plymouth, Plymouth. The second prize goes to Martin Fenerty, of Maghull, Liverpool. Runners up are J. Daniel, of Sevenoaks; Ken; R. Lorenz, of Henley-in-Arden, Warwickshire; J. Ross, of Harrow-on-the-Hill, Middlesex; L. Waits, of Norwich; Mia Williams, of Cambridge; and J. A. Youngman, of Felpham, West Sussex.

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Closing date: 8 July, 1988.

The post will be available from 1 September, 1988

For further details write or telephone the Personnel Office,
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An application form and job description is available quoting Ref. no. from the Personnel Department, North Tees General Hospital, Hardwick, Stockton-on-Tees, Cleveland. Telephone number (0642) 672122.

Closing date: Monday 27 July, 1988.



**North Tees
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2-33

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Candidates for the post should have a good honours degree in statistics or in engineering, physical, mathematical or management science and a postgraduate qualification in statistics. Higher degrees, research and teaching experience would be a desirable additional qualification for the post.

Salary for the post will be on the scale for University Lecturers between £9260-£19 310 pa.

Further particulars and application forms, to be returned by 15 July 1988, are available from Sandra Gardner, Personnel Department, Silsoe Campus, Silsoe MK45 4DT. Tel (0525) 60428.

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Initial appointment will be for one year on a salary scale commencing at £9865. Candidates should be available to start in September 1988.

Further particulars and application forms from The Personnel Office, The University, Regent Walk, Aberdeen AB9 1FX (Tel 024 273500) to whom applications (two copies) should be returned by 18 July, 1988, (WD/094).

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Application forms and further particulars may be obtained from the Personnel Officer (Academic Staff), quoting Ref: 8816/32, Aston University, Aston Triangle,



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At Farnborough we undertake an unusually wide variety of study and research projects as well as contracts in specialist technology areas such as radar and missile systems. Typical project length is 6 months and teams tend to be small, often working on client sites and enjoying the satisfaction of being involved from concept through to final report or end product.

With such constant variety plus training geared to all-round development, it's not surprising that Scicon is so attractive to talented graduates looking for the chance of early project management and a policy of promotion through achievement.

Right now we need more such

people - ideally those with a good degree followed by proven experience in modelling or software development within a defence systems environment. People who've acquired skills like VAX/VMS, FORTRAN/PASCAL/ADA on simulation design, graphics and operational analysis, and are now ready to move onwards and upwards.

Apart from the obvious career advantages, we offer rewards which include a package of benefits which ranks with the best in our industry.

For more information telephone Chris Smith on (0252) 541402, or write with your cv to: Kate Angwin, Personnel, Scicon Limited, 49 Berners Street, London W1P 4AQ. Alternatively telephone her on 01-580 5599 for an application form.

SCICON
SCICON

MRC

Medical Research Council
Laboratory of Molecular
Biology, Cambridge

**ORGANIC
CHEMIST**

Applications are invited for a post-doctoral position on the scientific staff of the Laboratory within a research group working in the peptide and oligonucleotide field. Experience in peptide synthesis would be an advantage but is not essential. Applicants should have a PhD degree in organic chemistry and a keen interest in bioorganic chemistry.

The position is available from 1 September, 1988 and is for three years duration subject to confirmation after the first year. Salary within the range £11 070-£14 500 depending on experience. Further information may be obtained from Dr R. C. Sheppard, Tel (0223) 248011, Ext 264.

Applications including cv and the names and addresses of two professional referees should be sent as soon as possible quoting ref D/2255, to the Personnel Officer, MRC Laboratory of Molecular Biology, Hills Road, Cambridge CB2 2QH.

The Medical Research Council is an Equal Opportunity Employer.

BRITISH MUSEUM (NATURAL HISTORY)

RESEARCH FELLOW Department of Entomology

The British Museum (Natural History) is primarily an institution with an international reputation for taxonomic research and has world-wide collections of animals, insects, plants and minerals. There are five scientific departments: Zoology, Entomology, Palaeontology, Mineralogy and Botany, which are supported by a comprehensive Department of Library Services and full technical services including electron microscope and computer facilities.

The Department of Entomology contains the largest and most comprehensive collection of insects in the world with about 24 million specimens, including approximately 450 000 species.

We are looking for a Junior or Senior Research Fellow to undertake taxonomic studies on anopheline mosquitoes including those species which transmit human diseases. You will be involved in the development of modern techniques for distinguishing between species, and in collaborative research with other scientists in this country and overseas.

You must have a good honours degree in a relevant subject with at least two years postgraduate experience (four years for the senior post), preferably involving work with disease-carrying insects.

The appointment will be initially for a period of three years with the possibility of extensions to five years and/or permanent appointment.

Salary: £10 347-£15 021 (inclusive of £1527 Inner London Weighting). Starting salary according to qualifications, experience and level of appointment.

For further details and an application form (to be returned by 15 July, 1988) please contact—

Miss Clare Beckett
Personnel Section
British Museum (Natural History)
Cromwell Road
London SW7 5BD
Tel 01-938 9441

The BM(NH) is an equal opportunity employer.

Bristol & Weston Health Authority Bristol Royal Infirmary Scientific Officer (Quality Control)

A chemistry graduate is required as an assistant to the District Quality Controller. The post involves analysis of raw materials and medicinal products using standard titration techniques, UV spectrophotometry, HPLC and other methods. The laboratory is complemented by the sub-regional quality control laboratory at Manor Park Hospital, where more sophisticated equipment is available. The post holder will be responsible for ensuring the smooth running of the laboratory, health and safety aspects, and involvement in the training of pre-registration pharmacy graduates in the work of the laboratory.

Entry is at probationer grade for those with no previous experience, those with previous experience may achieve higher grading. Starting salary for a probationer with 1st or 2nd class honours degree is £7825-£9828.

For informal enquiries, job description and application form please telephone or write to: Dr P. D. Harrison, Principal Pharmacist, Bristol Royal Infirmary, Marlborough Street, Bristol BS2 8HW. Tel 0272 250000, Ext 2370.

Closing date for applications is 20 July, 1988.

We are working towards equal opportunities in employment.

ROYAL FREE HOSPITAL Department of Histopathology COMPUTER OFFICER/ SCIENTIST

Salary: £12 619-£14 084 (including London Weighting Allowance).

Graduate in biological sciences (with computer interest and skills), or in computing, required to maintain and develop the departmental computer systems (DEC, PC, AMIGA) using a variety of software for departmental activities. The department undertakes service work, research and teaching. Computer applications include reporting of histopathological specimens, morphometry and laser video-computer teaching programmes. The computer officer will have facilities for research, and study for a higher degree will be encouraged.

Application form and job descriptions are available from The Personnel Department, The Royal Free Hospital, Hampstead, London NW3 2QG. Tel 01-794 0500, Ext 4286.

Closing date: 14 July, 1988.

ST MARY'S HOSPITAL MEDICAL SCHOOL (University of London)

Norfolk Place, London W2 1PG

Applications are invited for the post of MLSO in the Academic Haematology Department. The successful applicant will assist the Head of Department in conducting various research projects on the pathophysiology of the bone marrow and the mechanisms of alcohol toxicity. Salary range £6686-£9435 pa (under review) plus £1201 pa London Allowance dependent upon age and experience.

Applications should be sent to Assistant Secretary (Personnel) at the above address in form of a full cv and names and addresses of three referees by 18 July, 1988. Please quote Ref SW/MLSO.

Senior Chemist

Eastwood, South Essex

We are Britain's leading Waste Management Company and pride ourselves on the expertise of our Technical Services and support functions. Following a career development move, we now have a vacancy for a Senior Chemist based at our Eastwood Laboratory.

The Laboratory provides an essential service to the Company and other customers in such areas as waste evaluation, surface and groundwater analysis, air monitoring for dusts, organics and asbestos using traditional and instrumental techniques.

We are therefore looking for a Senior Chemist to maintain and control the analytical services provided, in particular, surface and groundwater analysis. This will involve managing a small team of analysts and the preparation and authorisation of Technical Reports.

Suitable candidates will be qualified to graduate level or equivalent with several years experience in an analytical laboratory. Actual experience in a water related field using instrumental techniques such as atomic absorption, chromatography, continuous flow chemistry, auto titration, etc., would be a distinct advantage.

We offer an attractive salary, together with excellent terms and conditions of employment, including a relocation package where appropriate.

In the first instance please telephone or write for an application form to:

CLEANAWAY
A GKN-Brambles Enterprise

Mrs Helen Ashelford,
Cleanaway Limited,
Airborne Close
Arterial Road,
Leigh on Sea,
Essex SS9 4EL.
Tel: (0702) 510088

DEPARTMENT OF TRADE AND INDUSTRY

Home and Leisure Safety Research Opportunities

The Safety Research Section, based in Victoria Street, London, is a small team which monitors home and leisure accidents in both the UK and the EEC. Much of the work is of an operational research nature aimed at identifying the most effective accident prevention measures.

We currently have two vacancies in this busy multi-disciplinary group.

You will be conducting or supervising research into consumer safety matters, developing information systems relating to consumer safety, providing information and advice.

You should have a good honours degree or equivalent, supported by good numerate skills. A knowledge of safety and operational research would be an advantage.

Starting salary £10-£14,000. Relocation assistance may be available.

For further details and an application form (to be returned by 22 July 1988) write to Mr P.L. Ratcliffe, Personnel Management, DTI, 1st Floor South, Allington Towers, 19 Allington Street, London SW1E 5EB. Telephone 01-215 0066. Please quote ref: SA/12/M.

The Civil Service is an equal opportunity employer

Scientific
CIVIL SERVICE

UMIST

Department of Textiles

SERC CO-OPERATIVE RESEARCH

A three year project covering a structural analysis of friction-spun yarns made from new cellulosic fibres has been sponsored by SERC, Courtauld and Platt Saco Lowell. The following posts are available from 1 October, 1988:

RESEARCH ASSOCIATE

Applications are invited from persons with PhD or equivalent in Textile Technology, Physics, Materials Science or a related discipline, to carry out original research in the area of fibres and yarn physics. (Ref T/R/67).

Commencing salary will be within the range: £9865-£15 720 per annum.

RESEARCH ASSISTANT

Applications are invited from persons holding an Honours degree (Minimum Class 2 (i)) in Textile Technology, Physics, Materials Science or a related discipline, to undertake research involving the spinning of novel fibres into yarns, using the latest technology and the correlation of the measured fibre and resultant yarn properties. The successful candidate will be encouraged to register for a higher degree. (Ref T/R/68).

Commencing salary will be within the range: £8675-£11 680 per annum.

Applications, quoting the appropriate reference number and including full cv and the names of two referees, should be sent to: Prof P. W. Foster, Department of Textiles, UMIST, PO Box 88, Manchester M60 1QD, to whom informal enquiries may be made.

Analyst

BDH Limited, the leading UK manufacturer and supplier of liquid crystal products, require an experienced Analyst to join the busy Quality Assurance section, involved in the analysis and quality control of liquid crystal materials.

Experience in instrument and chromatographic techniques is desirable. Applicants should preferably hold at least a higher certificate in chemistry or equivalent.

Salary will be according to age, qualification and experience and will be accompanied by a first class benefits package.

Applications with a full c.v. should be sent to: Mr J.M. Gordon, BDH Limited, Broom Road, Parkstone, Poole, BH12 4NN.

BDH

Essential Science

Trainee Editorial Assistants

Oxford

We require two Trainee Editorial Assistants to join a lively team engaged in the publication of a series of major scientific and scholarly encyclopaedias and reference works.

The successful applicants will chiefly be responsible for linguistic and scientific editing of manuscripts, proof reading and liaising with authors, editors and printers.

A degree in chemistry, physics or related disciplines is essential, and research experience would be an advantage.

Please ring Oxford 64881 ext. 3413 for an application form or write in confidence to: The Personnel Director, Pergamon Group of Companies, Headington Hill Hall, Oxford OX3 0BW.



VACANCY UPDATE!

TECHNICAL SALES

Electrophoresis/EIA —SW/SE/Mids
UV/IR Spectroscopy —All Areas
Molecular Biology —N. H. Counties
HPLC/GC/Data Hdg —NE/NW/UK

Aged 23-35; relevant technical knowledge; commercial flare but no sales experience required. Salaries in range £9K-£16K+benefits.

These opportunities, and many more are a phone call away...

SUPPORT SPECIALISTS

HPLC/GC —W/N Home Counties
Main Spec —South East
UV/IR Spec —N. H. Counties/Mids
Fluor Spec —Basset Bucks

Aged 23-35; relevant technical knowledge; commercial flare but no sales experience required. Salaries in range £9K-£16K+benefits.

These opportunities, and many more are a phone call away...

DELTA CONSULTANTS

Specialists in Business & Technical Recruitment

St. John's Innovation Centre, Cowley Road, Cambridge CB4 4WS
Tel: 0223 541127/541125

PUBLIC HEALTH LABORATORY SERVICE BOARD

Public Health Laboratory, Guildford

MEDICAL LABORATORY SCIENTIFIC OFFICER OR JUNIOR 'B' MLSO Microbiology

Applications are invited for the above post from a MLSO with experience in microbiology or graduate with a relevant science degree acceptable for state registration.

Further information and job description from Mr J. P. Alexander —Head MLSO, Guildford GU60 0R1.

Applications stating age, qualifications and experience, together with names and addresses of two referees to Prof R. Y. Cartwright, Public Health Laboratory, St Luke's Hospital, Guildford GU1 3NT.

Closing date: 22 July, 1988.

POLYTECHNIC OF CENTRAL LONDON

School of Building and Surveying

RESEARCHER B

Salary £11 288-£14 468 according to qualifications inclusive of London Allowance

PHYSICISTS/ENGINEERS/ARCHITECTS To join a thriving research team saving energy and increasing comfort in domestic and commercial buildings.

The appointee may represent the Research in Building Group on an international Agency Task concerned with Advanced Solar and Low Energy Buildings.

The post, starting in September, is for two years, extendable to three. Interviews will be held in August.

Please telephone 01-580 2020 Ext 2136 (answerphone) for an application form and further details or write to personnel Department, PCL, 309 Regent Street, London W1R 8AL, quoting Ref 4586. Closing date for receipt of completed application forms is 13th July, 1988.

PCL is an equal opportunities employer

The Royal Society

POLICY RESEARCH

The Royal Society has a vacancy for a person with experience of research in science, engineering or economics, to work in the Science and Engineering Policy Studies Unit. SEPSU collects data and undertakes objective, disinterested analysis so as to help those in academe, industry and Government responsible for formulating policy for science and engineering. Our four main research programmes cover the organisation and management of research, evaluation of performance, exploitation and international issues.

The person appointed will be expected to carry out original research, under the direction of the Head of the Unit, on a range of policy issues and may be required to work on several projects at any one time. Initiative, versatility and ability to work on pressurised deadlines are essential. Good writing and computing skills are also important.

SEPSU is run jointly by the Royal Society and the Fellowship of Engineering; its staff are located at the Royal Society. The appointment will be for up to three years in the first instance. The position is graded Administrative Assistant on a scale ranging from £10 125-£13 130 inclusive of London Allowance. Leave entitlement is 22 days plus an additional 4 travel days.

Application forms are available from Miss Sandy Orton on 01-839-5561 (Ext 310) and should be completed and returned by Friday, 22 July.

DRUG REGISTRATION OFFICER

Wyeth Laboratories is part of an international pharmaceutical company with wide ranging interests in the development, manufacture and marketing of medicines and nutritional products.

We now require an additional Scientist to join a professional group involved with drug registration in the UK and Ireland. The post involves the review and collation of data for product licence and clinical trial applications, maintenance of existing licences and advising on regulatory affairs.

Applicants should possess a life science or biomedical degree and have a minimum of a year's work experience, preferably in the regulatory field.

A meticulous approach to work and a high level of ability to organise and present scientific material in a clear and concise manner is essential. Applicants also require good communicative and interpersonal skills.

Company benefits include 24 days' annual holiday, a contributory company Pension and Life Assurance scheme and an excellent staff restaurant.

Please write with full personal and career details or telephone for an application form to:



The Personnel Officer,
Personnel Department,
Wyeth Laboratories,
Hunterscombe Lane South,
Taplow, Nr. Maidenhead,
Berkshire, SL6 0PH.
Tel: Burnham (06286) 4377 ext 4341.

Wyeth Laboratories

Plant Biotechnology

Develop your interest in Plant Molecular Biology

As part of its international Seeds Business, ICI is expanding its research in Plant Molecular Biology. We are looking for talented and imaginative individuals interested in plant biotechnology who are capable of working in a team and assimilating new techniques quickly.

Your work will focus on the cloning of commercially important plant genes. Ideally, candidates should have a good, relevant Honours degree (or equivalent) and some practical experience of DNA cloning, blotting and

sequencing techniques. Recent graduates are also encouraged to apply.

Located at our Jealott's Hill Research Station, you will receive a range of excellent company benefits including competitive salary and pension scheme.

Please write with full C.V. quoting ref: PLANTBIO3 to: Karen Grant, Recruitment Office, ICI Seeds, Jealott's Hill Research Station, Bracknell, Berkshire RG12 6EY. Closing date: 22nd July 1988.

ICI is an equal opportunities employer.



Seeds

EMBRYOLOGIST

Applications are invited for a position in an active Fertility and In-Vitro Fertilisation Unit to join the existing team.

The successful applicant will be expected to undertake all aspects of laboratory work and, although experience in mammalian embryology is preferable, full training will be given. It would be an advantage if applicants were to have a PhD or MSc. in Reproductive Physiology or Embryology. The Hospital offers a generous salary and an excellent benefits package.

Applicants should apply in writing, including a cv with the names of two referees, to the Personnel Department.

Date of commencement by mutual agreement.

Humana Hospital Wellington

Wellington Place London NW8 9LE

EDITORIAL STAFF

Applications are invited from recent or prospective Chemistry graduates for the position of Assistant Editor on our internationally renowned primary research journal **Dalton Transactions** (inorganic chemistry).

The successful candidate will form part of a small team, and after an initial training period will be expected to participate in all stages of publication, with the minimum of supervision.

He/she should possess a good honours degree, a keen eye for detail, be able to write in clear concise English and work carefully and quickly in accordance with schedules.

Initially based in Central London, the position will be transferred to our prestigious new premises on the Milton Road Science Park, Cambridge from February 1989.

For further details please contact Vivienne Harding, 30 Russell Square, London WC1B 5DT. Tel 01-631 1355.

Closing date: 15 July, 1988.

NEWCASTLE UPON TYNE POLYTECHNIC
This is an equal opportunities advertisement
FACULTY OF ENGINEERING, SCIENCE & TECHNOLOGY
 Department of Chemical & Life Sciences

ASSOCIATE LECTURER IN CHEMISTRY (2 Posts) 50%

Grade: Lecturer or Senior Lecturer

Ref No A34/88

The above posts are available from 1 September, 1988. Candidates should possess a good honours degree or equivalent and have had appropriate teaching experience. Possession of a higher degree and appropriate research and/or industrial experience would be highly desirable.

The successful candidates will be expected to teach one or more branches of Chemistry (ie Analytical, Inorganic, Organic, Physical) to BTEC HNC, and degree standard. They may also be required to assist in teaching of courses serviced by the Department.

For suitably qualified candidates there may be the opportunity to participate in project supervision and research. There will be administrative and organisational responsibilities associated with the posts.

The posts are associate lectureship equivalent to 50 per cent lectureship in terms of salary and duties.

Lecturer in Inorganic/Analytical Chemistry

Ref No A33/88

The above post is available from 1 September, 1988. Candidates should possess a good honours degree or equivalent and have had appropriate research and/or industrial experience. A higher degree would be highly desirable.

The successful candidate will be expected to teach Inorganic and some aspects of Analytical Chemistry up to honours degree standard, and to assist in the teaching of courses serviced by the Department. The person appointed will be expected to undertake research, either by joining a research group in the Department, or in collaboration with an industrial or other laboratory by attracting external funding.

NJC for Lecturers in Further Education: (with effect from 1 July, 1988). Lecturer £8481-£15 369, SL £15 369-£17 490 (bar) £18 549 pa. (Associate Lecturer salary will be 50 per cent of above scale).

For further details and application forms please call our 24 hour answering service (091) 2323126 or write enclosing foolscap s.a.e. to Miss Elsie Thorpe, Administrative Assistant (Recruitment), Newcastle upon Tyne Polytechnic, 1 Ellison Place, Newcastle upon Tyne NE1 8ST to whom completed forms should be returned quoting the reference number by 29 July, 1988.

UNIVERSITY
OF STRATHCLYDE
DEPARTMENT OF PURE
AND APPLIED CHEMISTRY

TECHNICIAN

Grade 5 £8088-£9549

Required to undertake organic synthetic work connected with an industrial contract. This is available initially for two years and can commence at any time between 1 July, 1988 and 1 October, 1988.

Candidates should have experience in organic synthesis and a Higher National Certificate or equivalent in chemistry.

Applications in writing (quote Ref: T10/88) enclosing a cv and giving two referees, should be sent to the Staff Office, University of Strathclyde, McCann Building, 16 Richmond Street, Glasgow G1 1XQ. Only those applicants called for interview will have their applications acknowledged.

Closing date: 15 July, 1988.

UCG Coláiste na hOllscoile Gaillimh

UNIVERSITY COLLEGE GALWAY
Applications are invited for a position as

RESEARCH ASSISTANT

to work on an Eolas funded project on "Particulate Matter in Atlantic Air", from graduates with knowledge of Atmospheric Physics and Computing.

This position is a full time post for two years commencing 1 September, 1988.

Applications with full cv and names of two referees should be sent by 22 July to:

The Secretary,
Department of Physics,
University College, Galway.

THE UNIVERSITY OF LEEDS
Department of Statistics
PREDOCTORAL RESEARCH ASSISTANT

Applications are invited for the above post from 1 October 1988 for a fixed period of three years for work on automated spatial cluster analysis of digitized images under the Complex Stochastic Systems Initiative.

A good honours degree in Mathematics/Statistics and in the area of computing are required.

Salary on R/A IB (£8675-£11 680) according to qualifications and relevant experience.

Informal enquiries may be made to Prof K. V. Mardia. Tel 0532-335 100/1.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT quoting Ref No 51/24. Closing date for applications 19 July, 1988.

NATIONAL INSTITUTE FOR
MEDICAL RESEARCH
LABORATORY OF GENE
STRUCTURE & EXPRESSION

JUNIOR TECHNICIAN

A vacancy has arisen for a Junior Technician to assist the Head Technician in the day to day running of the Lab. Initially, duties will involve checking in goods from stores, other routine duties within the Lab and responsibility for preparing and maintaining stock of a number of routine reagent/buffer solutions required. The technical duties will be increased as the successful applicant gains experience.

This vacancy would suit a school leaver with an interest in the sciences. Applicants should have a minimum of four 'O' levels (or equivalent). Day release facilities to attend college can be made available. Salary will be within the range of £4394 at age 16 to a maximum of £6585.

The National Institute for Medical Research has a world wide reputation for excellence in biomedical research and offers first rate facilities in congenial surroundings.

Please telephone for an application form to 01-259 3656, or write to Miss C. J. Oldham, Assistant Personnel Officer, NIMR, The Ridgeway, Mill Hill, London NW7 1AA quoting reference 0552/GSE.

An Equal Opportunities Employer.

MRC

Medical Research Council
Neuro-Otology Unit

PHYSICIST/ELECTRONIC ENGINEER

Applications are invited from candidates with good formal qualifications and experience in microprocessor hardware/software techniques, to join a multi-disciplinary team of scientists engaged in research into human movement and balance. The appointee will have responsibility for programming, computer-laboratory interfacing, the design of novel laboratory apparatus and will be encouraged to participate in research projects and register for a higher degree.

Appointment will be made in the Research/Senior Research Officer grade (£7554-£12 179 plus £1202 LW).

Applications in writing with the names and addresses of two referees and full cv to: The Director, MRC Neuro-Otology Unit, National Hospital, Queen Square WC1N 3BG.

ARE YOU REASONABLY GOOD AT EVERYTHING?

Are you good at understanding, explaining, programming, planning? Do you find most other people also on the uptake but you've learned to be patient with them? If you are into micro-computers, prepared to work in London/Oxford and these questions interest you, write with cv to: Gail Simmons, OCTS, Wolsey Hall, 66 Banbury Road, Oxford.

Research Assistant

Department of Geology

The Department of Geology seeks to recruit a person to work in the field of environmental radioactivity. Candidates having a practical knowledge of radiation detection and measurement, computer programming (Fortran & Basic) and an interest in Health Physics should apply to the address below. The position is available for a 5 year period subject to satisfactory completion of a 1 year probationary period. Candidates should ideally hold a PhD or MSc. Salary is on the 1A or 1B scale (Starting salary approximately £8675 depending on age and qualifications).

Applications and cv's should be sent to: Dr Ian W. Croudace, Geology Department, The University, Southampton SO9 5HN. Please quote reference NS.

THE UNIVERSITY OF MANCHESTER

TEMPORARY LECTURER IN INORGANIC CHEMISTRY

Applications are invited for the above post, tenable for one year from October 1, 1988. Duties will consist of lecturing, supervision of laboratory classes and undergraduate research projects. The successful applicant should be of postdoctoral status and would be expected to carry out research in some area of inorganic chemistry. Salary within range £9260-£11 680 (Lecturer A Scale) according to qualifications and experience. Superannuation. Applications, including a cv, a summary of proposed research which would be undertaken and the names and addresses of two referees should be sent as soon as possible, and before July 18, to Prof C. D. Garner, Department of Chemistry, University of Manchester, Manchester M13 9PL. The University is an Equal Opportunities Employer.

UNIVERSITY OF BRISTOL

Department of Biochemistry

POSTGRADUATE RESEARCH ASSISTANT

required for a three-year project from 1 October 1988, funded by SERC, to investigate the regulatory properties of the glycolytic enzyme Pyruvate Kinase using the techniques of X-ray crystallography and site-directed mutagenesis. Salary on 1B scale up to £9805 pa. The research will be under the direction of Dr W. Chia and Dr H. Muirhead and applicants should have a good honours degree in Biochemistry, Chemistry or a related subject. Further information from, and applications with cv and names and addresses of at least two referees to: Dr H. Muirhead, Department of Biochemistry, University of Bristol, Bristol BS8 1TD, as soon as possible.

Leeds Western Health, Authority
THE GENERAL INFIRMARY
AT LEEDS

SENIOR/BASIC GRADE MYCOLOGIST

Regional Mycology Laboratory

Applications are invited for the above post based in the Department of Microbiology. The laboratory is engaged in the routine diagnosis of fungal diseases for the Yorkshire Region.

The person appointed will assist with the administration, running and development of the diagnostic service. Applicants should have a good honours or postgraduate degree in Microbiology or related subject and have experience of work in a diagnostic microbiology laboratory, preferably with medically important fungi.

The appointment will be on an appropriate point of the Senior/Basic grade scale depending on qualifications and experience.

Informal enquiries to Dr Evans (Senior Lecturer) on Leeds (0532) 335600.

Salary: Senior Grade: £11 164-£14 591 pa. Basic Grade: £7825-£9828 pa.

Application forms and job descriptions available from the Personnel Department, Leeds General Infirmary, Great George Street, Leeds LS1 3EX. Tel Leeds (0532) 437110/437154.

Closing date: 22 July, 1988.

UNIVERSITY OF NEWCASTLE
UPON TYNE
Department of Pathology

Research Associate (Postdoctoral)

Applications are invited from postdoctoral Biochemists/Biologists/Immunologists to work a project concerned with production of monoclonal antibodies using synthetic peptides to the human c-fos oncogene. The post is available for two years. Commencing salary up to £11 680 pa on the grade 1A scale (£9805-£15 720).

Applications with full cv and the names of three referees, should be sent to Professor C. H. W. Horne, Department of Pathology, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP, not later than 1 August, 1988.

PARKSIDE HEALTH AUTHORITY

St Mary's Hospital, W2
BASIC GRADE BIOCHEMIST (Ref No PTA/329).

£9026-£11 029 inc of London Weighting.

A Biochemist/Molecular Biology graduate is required to join a service and research team interested in hormone biosynthesis and action. A first or upper second class degree would ordinarily be required.

Application forms and job description available from Unit Personnel Department, Acrow Building, St Mary's Hospital, Praed Street, London W2 1NY. Tel 01-262 3456, Ext 229/247.

Closing date: 15 July, 1988.

Working towards Equal Opportunities.

SENIOR MATERIALS TECHNOLOGIST

Cementation Research Limited, the R&D Centre of TH Technology Limited, has a vacancy for a Senior Materials Technologist who is needed to spearhead development work in a multi-national, collaborative project.

The post provides an opportunity for a well qualified materials scientist/engineer with several years experience to contribute significantly to the introduction of new construction techniques in the field of civil engineering.

Familiarity with the theoretical and practical aspects of concrete technology is essential, and applicants should possess an aptitude for innovative applied research.

As co-operation with other laboratories is an important feature of the project, an ability to communicate well, both orally and in writing, is vital.

An attractive salary plus company car will be offered, together with the usual benefits associated with a major group. This appointment offers excellent prospects for future advancement.

Please apply to R.M. Edmeades, Cementation Research Limited, Denham Way, Maple Cross, Rickmansworth, Herts. WD3 2SW. Tel: 0923 7786.

TH TECHNOLOGY
LIMITED



MIDDLESEX POLYTECHNIC
Urban Pollution Research
Centre

Research Students and Research Assistants in Air Pollution Research

Required from 1 October in these areas:
Vehicle Emissions: to investigate the emission rates of pollutants, including polyaromatic hydrocarbons, as a function of engine type and characteristics and to assess their environmental impact.

Vehicle Instrumentation: to develop instrumental methods of recording a range of vehicle operating characteristics, relevant to pollutant emissions.

On-site on Buildings: to investigate the impact of airborne particulate matter on buildings.

All projects involve close collaboration with major industrial and public sector organisations. Salary in the range £4000-£10 000 pa.

Those with, or expecting to receive, a good honours degree in an appropriate scientific or engineering discipline should apply in writing including a full cv, an indication of the preferred project, and the names of two referees, to: Dr R. Hamilton, (Ref C43 1C, Middlesex Polytechnic, Queensway, Enfield EN3 4SF. Tel 01-368 1299. Closing date 6 July, 1988.

DIRECTOR

Charles Darwin Research Station
(CDRS) Galapagos Islands, Ecuador
The Charles Darwin Foundation for the Galapagos Islands (CDFI) is seeking a Director for its international research, conservation and education centre, the CDRS.

Duties: administration of CDRS, including over 50 scientific and support staff; organization/supervision of annual process of planning, execution and evaluation of Station's programmes, within guidelines established by CDF and agreements with Ecuadorian government; provide effective technical cooperation to many Ecuadorian counterpart agencies, especially Galapagos National Park Service (GNPS), both for management of the national park (97% of 8,000 km² land area) and new 80,000 km² Marine Reserve and planning wise development of the islands; supervise extensive training and educational programmes for university students and general public; obtain substantial proportion of Station's annual budget via preparation of proposals and reports.

Qualifications: MS, preferably PhD, or equivalent in a field of natural sciences, natural resources management or similar; minimum 4 years practical experience in one's field, preferably in Latin America, bilingual English/Spanish, 30-50 years of age and good physical condition, demonstrated ability for team leadership with persons of wide variety of educational training and cultural backgrounds, enjoy living and working in isolated conditions and different cultural setting, preference also for candidates with experience in administration of similar institutions or programs, applied conservation research and/or training and educational programme design and practice.

Benefits: basic salary US\$15,000 per year with possible increment depending upon experience, travel housing and health and life insurance, international transport of director, family and personal belongings, repatriation allowance for each year of service, contract for two years initially, renewable.

Applications: with cv and three letters of recommendation to: CDRS, President CDFI, 836 Mayfield, Moscow, ID 83843, USA. Closing date 15 September 1988.

Toxicology Section Head

(£15,000 - £20,000 +)

Our client is a major British Pharmaceutical company with an international reputation for research and development. Evaluating the safety of their new medicines is an essential and continually expanding activity.

They wish to appoint a section head to manage a team of graduate toxicologists responsible for the design, conduct, reporting and evaluation of toxicity studies to GLP standards. The position offers considerable scope to a scientist who has both experience of running *in vivo* safety evaluation programmes and a sound understanding of the toxicology of therapeutic agents, and who now wishes to extend this expertise on a broad front.

Besides a good honours degree in an appropriate discipline, and at the very least five years' relevant experience, the successful candidate will be an able communicator who can relate effectively to staff at all levels.

Starting salary will be dependent on qualifications and experience. In addition our Client offers an attractive company bonus scheme, non-contributory pension, free life assurance, and where appropriate generous relocation assistance.

Please send a complete CV including current salary to Juniper Woolf & Partners Limited, 22 New Concordia Wharf, Mill Street, London SE1 2BB. Applications will be forwarded direct to our Client and should be clearly marked on the envelope with the reference number C240.



RECRUITMENT ADVERTISING

SEARCH & SELECTION

UNIVERSITY OF LANCASTER

POSTDOCTORAL RESEARCH FELLOW IN TRUE DIGITAL CONTROL SYSTEM (TDC) DESIGN

TDC is an exciting new approach to direct digital control system design developed at Lancaster. Applications are invited for an SERC-funded, three-year appointment working on this topic with Professor Peter Young and Dr Arun Chota in the Control and Systems Group of the Centre for Research on Environmental Systems. The research will be concerned with the design of fixed gain and adaptive TDC systems in a wide range of application areas; and will involve the development of an advanced CAD program functioning with the new ECSTASY software environment on a SUN graphics workstation. The project will be carried out in collaboration with Mr C. Cox, Department of Electrical, Electronic and Control Engineering, Sunderland Polytechnic and British Gas PLC. The appointee should have a strong background in control or computing.

Starting salary up to point four (£11 680) on the Research 1A scale (£3865-£15 720 pa).

Further details and application form available from the Establishment Office, (quoting Ref L 410), University House, Bailrigg, Lancaster LA1 4YW, where applications (five copies) should be received by 19 July, 1988.

UNITED MEDICAL AND DENTAL SCHOOLS

Guy's Campus—close to London Bridge BR and Underground Stations
LABORATORY SCIENTIFIC OFFICER

required in Department of Immunology to work on the malaria. Techniques used will include microscopy, tissue culture, chromatographic and electrophoretic analysis of macromolecules. Applicants should hold H.Tech. in parasitology and/or immunology specialisation and research laboratory experience.

Starting salary in range £5867-£7481 pa plus £1201 pa London Weighting, depending on qualifications and experience.

For further information please contact Dr G. H. Mitchell on 01-407 7600, Ext 3365.

Applications, with full cv and names of two referees, to the Staffing Officer, UMDS, St Thomas's Campus, Lambeth Palace Road, London SE1 7EH, quoting Ref G/IMM/188.

Heriot-Watt University Department of Civil Engineering RESEARCH ASSOCIATE IN GEOTECHNICAL ENGINEERING

The engineering geology of the extensive deposits at the National Soil City Test Site, Bournemouth, Grangemouth.

The SERC is funding a two-year study at the National Soil City Test Site in order to establish the engineering geology of the subsurface deposits. This work will provide basic information for the interpretation of future large-scale tests at the site. The project will involve detailed examination of undisturbed sediment cores by means of both geotechnical and geochronological techniques.

Applicants should have a first or second class Honours degree in Civil Engineering or Earth Sciences in addition to a postgraduate degree in Engineering Geology or Geotechnics. Experience in modern sediment analysis techniques would be an advantage.

The salary will be in the range £6675-£11 682 and the post is for a period of two years from 1 October, 1988. Further information may be obtained from Dr M. A. Little or Dr J. A. Little, Tel 01-449 5111 Ext 4412 or 4413. Application forms may be obtained from the Staffing Officer, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS quoting ref no 47/88/NS.

UNIVERSITY OF ESSEX Department of Biology RESEARCH TECHNICIAN £6636-£7828 pa.

Applications are invited for the post of Research Technician (Grade 3) to carry out shipboard work as part of the NERC North Sea Programme, and analysis of sediment samples at the Scottish Marine Biology Association laboratory at Oban, Argyll. The post is for a period of 15 months, commencing in August 1988, or as soon as possible thereafter, and will be based at Oban.

Informal enquiries may be made to Dr D. B. Nedwell, University of Essex (0206 873307) or Dr R. J. Parkes, SMBA (0631 62244).

Applications in writing (quoting Ref N/731), including a cv and the names and addresses of two referees, should reach the Personnel Officer, University of Essex, Wivenhoe Park, Colchester CO4 3BQ by Friday, 15 July, 1988.

UNIVERSITY OF ABERDEEN POSTDOCTORAL RESEARCH FELLOW IN ECONOMIC GEOLOGY

Applications are invited for the above appointment to investigate the nature, genesis and palaeo-environment of a Devonian precious metal-bearing hot spring system near Rhynie in northeast Scotland. The successful applicant will be working with an experienced multidisciplinary team investigating this exciting prospect. Field experience of sedimentary geology and the application of fluid inclusion and isotopic techniques to ore genesis would be advantageous.

The work is supported by an NERC grant to Dr C. M. Rice as principal investigator. Appointment will be made on a salary scale commencing at £9865 for a period of 18 months to two years. Candidates should be available to start immediately.

Further particulars and application forms from the Personnel Office, The University, Regent Walk, Aberdeen AB9 1PX (Tel 0224 273500) to whom applications (two copies) should be submitted by 22 July, 1988. Ref (DA/023).

ROYAL POSTGRADUATE MEDICAL SCHOOL (University of London)

Department of Virology POSTDOCTORAL SENIOR RESEARCH OFFICER

Applications are invited for a small, active group, headed by Prof Peter D. Smith, investigating Epstein-Barr viral gene expression in human tumours. Experience in molecular biology or protein biochemistry would be an advantage.

Salary will be on Range 1A for University Research and Analogous Staff (currently £9865-£15 720 plus £1450 London Allowance), and the post is available initially for two years.

Application forms and further particulars may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Duane Road, London W12 0NN quoting Ref AVS1.

Closing date: 14 July, 1988.

UNIVERSITY OF BRISTOL Department of Obstetrics & Gynaecology

A RESEARCH TECHNICIAN is required in the Reproductive Medicine Unit, which provides a comprehensive infertility service including in-vitro fertilisation and artificial insemination and has an extensive programme of research with seminiology as one of its principal interests. Applicants should have a degree or equivalent qualification in a biological science, or previous laboratory experience. Appointment for one year initially, within salary range £6636-£7828 pa. Enquiries and applications inc. cv and names of two referees to: Dr W. C. L. Ford, Department of Obstetrics & Gynaecology, Bristol Maternity Hospital, Bristol BS2 8EG. Tel 0272 215411. Ext 268 within two weeks of the appearance of this advertisement.

The Medical College of St. Bartholomew's Hospital
West Smithfield, London EC1A 1BE

NON-CLINICAL LECTURER

Funded by NETRIA

Tenable in the Department of Chemical Endocrinology

Applications are invited for the above post which is tenable for a period of three years in the first instance. The post would suit candidates with a higher qualification in Biochemistry or a related subject and previous working experience of immunoassay techniques and clinical application. The appointee will be expected to participate in postgraduate and undergraduate teaching. The post will be remunerated on the Non-Clinical Lecturer scale, the exact point taking account of previous experience (Grade A Lecturer: £2600-£14 500; Grade B Lecturer: £15 050-£19 910) plus £1450p (London Allowance).

Copies of the job description can be obtained from the Medical College at the above address. (Tel. 01-606 7404) quoting Ref. JK.96. Applications in the form of a cv (5 copies please) should be sent to the Dean of the Medical College at the above address, together with the names of two referees, no later than Friday, 29 July, 1988.

THE UNIVERSITY OF LIVERPOOL

Department of Radiation Oncology

TECHNICIAN GRADE 5

To join the University of Liverpool's Cancer Research Campaign Research Department based at Clatterbridge Hospital, Wirral, with prime responsibility for running the tissue culture service. From time to time the postholder will deputise for the senior technician. Initial work will be to study the production of monoclonal antibodies.

Applicants should have seven years' relevant experience and be qualified to ONC or preferably HNC.

Salary within the range £8088-£9549 pa.

Quote Ref: PER/876/NS.

Closing date for the above post: Friday, 15 July, 1988.

Application forms available from the Registrar (NAS), The University, PO Box 147, Liverpool L69 3BX.

An Equal Opportunity Employer.

HAREFIELD HOSPITAL

Harefield, Bucks

Middlesex UB9 6JH 08952 3737

Transplant Immunology

Department

We are looking for two enthusiastic

Graduates (or HND) in Biology or Biochemistry

One person will work exclusively in the new Tissue Typing Unit, and will be trained in the procedures of tissue typing and cross-matching. The second person would rotate between general Immunology Laboratory (radioimmunoassay, histology, T cell analysis) and the Tissue Typing Unit.

For further details, telephone Dr M. L. Rose, Ext 370.

Applications by cv (in duplicate please) to the Personnel Department.

Salary as per Whitley Council (according to qualifications).

Closing date: 14 July, 1988.

UNIVERSITY OF CAMBRIDGE

Department of Pathology

Division of Virology

RESEARCH TECHNICIAN (R6)

post available in the Virology Division at Addenbrooke's Hospital, Hills Road, Cambridge, to join a small group working on a variety of problems including aspects of Thiers Virus (TWEV). This post may shed light on a possible viral cause of Multiple Sclerosis. Useful experience would include tissue culture methods and molecular biological techniques. The post is funded for three years in the first instance, and represents an opportunity to work on an interesting research programme in a lively and friendly working environment.

Qualifications: HNC/Degree in relevant biological subject.

Salary scale: £7145-£8275 (under review). Applications are also welcome from new graduates, but on a lower salary scale initially.

Applications in writing together with cv and names and addresses of two referees to: The Superintendent, Department of Pathology, Tennis Court Road, Cambridge CB2 1QP (Please quote PF 140).

MANCHESTER POLYTECHNIC

Department of Electrical and Electronic Engineering

RESEARCH ASSISTANTSHIP IN THE OPTICAL ACCESS NETWORK

Applications are invited for the above Assistantship (funded by British Telecom) to undertake research into the deployment of optical fibres within the telecommunications network (to the subscriber). The Research Assistantship is tenable for three years with a starting date to be agreed prior to autumn 1988. The salary will be in the range £7560-£9009 pa and the successful applicant will be expected to register for a higher degree.

Applicants should have, or expect to obtain, a good honours degree in Electrical and/or Electrical Engineering, Applied Physics or similar.

Further details and an application form returnable by 18 July, 1988 send a self addressed envelope marked T/943 to the Secretary, Polytechnic, All Saints, Manchester M15 6BH.

Manchester Polytechnic is an Equal Opportunities Employer.

ST HELIER HOSPITAL

Wrythe Lane, Carshalton, Surrey

SM5 1AA

BASIC GRADE/JUNIOR MISO

Vacancies exist in our District Pathology Laboratories for suitably qualified graduates in Medical Laboratory Sciences, Chemistry, Biochemistry, Microbiology—who after a period of training would be eligible for:

- State Registration
- Further study leading to MSc or Fellowship of the Institute of Medical Laboratory Sciences

Please contact Dr Mary Moore, Principal Scientific Officer at St Helier for further information on 01-644 434, Ext 2486.

Application forms are available from the Personnel Department on Ext 2631.

Closing date: 15 July, 1988.

Beckenham, Kent
£10,000-£12,000

- The Wellcome Foundation Ltd.
- Major International Pharmaceutical Group
- Main Production Centre at Beckenham
- Annual Turnover > £1,130m
- An Equal Opportunity Employer



Wellcome

Wellcome is a major international pharmaceutical group engaged in the research, development, manufacture and marketing of human health care products.

A vacancy has arisen within the Department of Diagnostics R&D for a Senior Technician within the Hepatitis/New Technologies Section. The successful applicant will provide scientific expertise and support necessary to assist in the identification/investigation of projects aimed at providing new/improved reagents or kits for Diagnostic purposes.

Applicants should possess a degree, or equivalent, in a biological subject: experience of immunoassay techniques would be an advantage.

Interested applicants should send full C.V. to Miss S.J. McKinlay, The Wellcome Research Laboratories, Langley Court, Beckenham, Kent BR3 3BS, quoting reference number 203.

**unilever
research**

Colworth Laboratory
 Sharnbrook, Bedford

Virology Technician

Colworth Laboratory, located 9 miles north of Bedford, is a major biotechnology and food research centre supporting the worldwide business interests of the Unilever organisation.

There is now a need for an able technician to join a small virology group to work on tissue and virus culture, development of diagnostic assays and the setting up of a hygiene programme.

Applicants should have at least HND/HNC in a relevant subject with one or two years experience in a routine diagnostic laboratory.

Salary on appointment will be in the £6000 to £8000 pa range, depending on the qualifications and experience offered. Other benefits are those of a typical multinational concern including five weeks holiday per year, pension scheme, flexible working hours and active social club.

To apply, please write or telephone for an application form to:

Recruitment Officer
 Unilever Research
 Colworth Laboratory
 Sharnbrook, Bedford MK44 1LQ
 Tel Bedford (0234) 222387
 (ansaphone outside office hours)

Unilever is an Equal Opportunity Employer



**ZOOLOGICAL SOCIETY OF
LONDON**

PROJECT MANAGER WILDLIFE RESEARCH CENTRE Saudi Arabia

The Zoological Society of London, acting on behalf of the National Commission for Wildlife Conservation and Development Kingdom of Saudi Arabia, is offering the post of Project Manager of the King Khalid Wildlife Research Centre near Riyadh.

The Centre consists of approximately 1000 acres and employs up to 10 scientific staff and 30 support staff. It is principally concerned with the biology of Desert Ungulates. Candidates should have a PhD or equivalent with a first degree probably in Veterinary Science or Zoology. They should have proven ability to manage and lead a team of specialists. The successful applicant must be able to cope with challenging conditions and preferably have considerable previous field experience.

A salary of £25 000-£30 000 per year is offered with other benefits. Further details and a Job Description can be obtained from **The Director of Zoos, The Zoological Society of London, Regent's Park, London NW1 4RY.**

THE ROYAL MARSDEN HOSPITAL

Fulham Road, London SW3 6JJ

Two vacancies, either

JUNIOR 'B' MLSO OR BASIC

MLS0—Histopathology/

Salary: £5410-£10 636 inclusive.

Applications are invited from those interested in pursuing a career in medical laboratory science within the Histopathology Department. The posts would include immunocytochemistry work and an interest in electron microscopy would be desirable.

Applicants for Junior 'B' should possess a minimum qualification of BTEC, HNC or equivalent, and for Basic Grade, the possession of State Registration is required.

Informal enquiries and visits to the department can be arranged by contacting Mrs D. Kellock, Chief MLSO, Tel 01-352 8171, Ext 2632.

Application form and job description are available from the Personnel Department at the above address, or Tel Exts 2146 or 2147. Closing date: 15 July, 1988.

UNIVERSITY OF CAMBRIDGE

Senior Research Associate—

Electrical Engineering

(Signal Processing)

SENIOR RESEARCH

ASSOCIATE

to work on the development of new areas of hearing aids. The project is funded for five years by an MRC Programme Grant, starting December 1988 (with some flexibility in the starting date). The project involves the development and evaluation of methods for processing speech in noise to enhance intelligibility. The ideal applicant would have experience both in analogue circuit design and digital signal processing techniques. He/she would be part of a multi-disciplinary team including speech scientists and psycho-acousticians. Salary on a scale ranging from £13 365 to £19 310. Applicants should send a cv to Dr B. C. J. Moore, Dept of Experimental Psychology, Downing Street, Cambridge CB2 3EB. Tel 0223 333574.

UNIVERSITY OF DURHAM

Department of Psychology

The Relationship between early visual processing and saccadic eye movements

Applications are invited from graduates in Psychology or a related subject with interests in Human Vision for a three year

RESEARCH ASSISTANTSHIP

tenable from October 1988 for the above work funded by the SERC Biological Image Interpretation Initiative and directed by Dr J. Findlay.

Initial salary £8675-£10 460 pa (Grade 1B) with USS.

Applications (three copies) naming three referees should be sent (quoting Ref Y1) by 15 July, 1988 to the Registrar, Science Laboratories, South Road, Durham DH1 1LE, from whom further particulars may be obtained.

UNIVERSITY OF LEICESTER

Molecular Biologists

RESEARCH ASSOCIATE AND

RESEARCH TECHNICIAN

Positions are vacant for a Post-graduate Fellow and a Research Technician (Grade 3) in the Department of Genetics. The project, funded by the SERC for three years involves the molecular analysis of the secretion mechanism of haemolysin and mammalian polypeptides from *Escherichia coli*. The project includes opportunities for acquiring genetic engineering skills in a large multi-disciplinary School of Biology with full modern facilities for DNA and protein analysis. The positions will be vacant from 1 October, 1988. Applicants should preferably have some relevant experience in Biochemistry. Genetics or related field with some knowledge of recombinant DNA techniques desirable but not essential.

Salary scales: Research Associate £10 636-£15 636; Research Technician £6366-£7822.

Requests for further information or applications together with brief cv and names of two referees to Prof Barry Holland, Department of Genetics, University of Leicester, University Road, Leicester LE1 7RH.

UNIVERSITY OF GLASGOW

Department of Mathematics

CHAIR OF MATHEMATICS

Applications are invited for appointment to the Chair of Mathematics, which was founded in 1691 and is one of the three established Chairs presently extant in the department. The appointment will be tenable from 1 January, 1989, or as soon as possible thereafter. The successful candidate will be expected to provide academic leadership in both research and teaching. Preference will be given to candidates with research interests in analysis, but other areas compatible with current research in the Department will also be considered.

Further particulars may be obtained from the Academic Personnel Office, University of Glasgow, Glasgow G12 8QQ, where applications (three copies; one copy in the case of overseas applicants) giving the names and addresses of three referees, should be lodged on or before 1 October, 1988.

In reply please quote Ref No 6246N.

INSTITUTE OF HORTICULTURAL RESEARCH

Littlehampton

LIBRARIAN

required for day-to-day running of Scientific Library. Candidates should have a degree in relevant scientific discipline with Diploma in Information Science/Librarianship or Associateship of the Library Association with at least five years professional experience in Librarianship. Experience of on-line information retrieval, preferably in an academic, scientific or technical library desirable.

Salary in range £10 622-£13 005.

Optional non-contributory pension scheme.

Further details and application form quoting Ref Y1/L from the Personnel Officer, Bradbourne House, East Malling, Maidstone, Kent ME19 6BJ.

Closing date: 22 July, 1988.

The Institute of Horticultural Research is an Equal Opportunities Employer.

UNIVERSITY OF SURREY

CONTRACT OFFICER

Salary up to £22 910 pa

Applicants are invited for the post of Research Contracts Officer to report to the Director of Industrial Liaison and to advise and assist members of the University in the submission of proposals for research grants and contracts. The post carries responsibility for the negotiation of contract terms and playing a major role in the procurement of successful contracts with industry and other bodies.

This is a very interesting senior appointment in a University with one of the highest research incomes per capita in the UK and with many commercial activities. It requires negotiating skills and familiarity with computerised management systems together with varied experience which will facilitate contracts with Government Departments, Research Councils and command the confidence of academic staff.

Applications in the form of a cv, including the names and addresses of two referees should be sent to the Personnel Office, University of Surrey, Guildford, Surrey, GU2 5XH, before 18 July, 1988, quoting Ref Y17/NS.

BIRKBECK COLLEGE

(University of London)

Centre for Analytical Science

RESEARCH ASSISTANT

(Conducting Polymer Gas

Sensors)

Applications are invited from candidates who have (or expect to obtain) a degree in chemistry to work on a British Gas-funded project concerned with the development of conducting polymer gas sensors.

The post will be available from summer 1988 for one year only in the first instance with the possibility of extension for a further year. Initial salary will be £10 125 pa inclusive of London Allowance.

Applications in duplicate including a full cv and names and addresses of two referees should be sent to the Assistant Secretary (Personnel), (NS/RA/CH), Birkbeck College, Malet Street, London WC1E 7HX by 15 July, 1988. Further details may be obtained from the above address.

Informal enquiries to Dr Jonathan Slater, Department of Chemistry, are welcomed (Tel 01-380 7474).

EASTBOURNE HEALTH

AUTHORITY

District General Hospital

MLS0/JUNIOR 'B' MLSO

HISTOPATHOLOGY/

CYTOTOLOGY DEPARTMENT

Applications are invited from state registered MLSO's, appropriate graduates or persons satisfying the entry requirements for BTEC/HNC in Medical Laboratory Sciences. This modern, well equipped laboratory offers good opportunities for those wishing to make medical laboratory science their career. The department undertakes a wide range of routine techniques together with immunocytochemistry, resin sectioning and electron microscopy, and has recently been converted to the Radius Histology/Cytology computer system.

For further information, application forms or to arrange informal visits, please contact: Miss C. White, Chief MLSO, Department of Pathology, District General Hospital, Kings Drive, Eastbourne, East Sussex BN21 2UD. Tel (0323) 21351, Ext 4014.

MRC CLINICAL RESEARCH CENTRE

(Northwick Park Hospital)

Watford Road, Harrow

Middlesex HA1 3UJ

RESEARCH

OFFICER

Applications are invited for a RESEARCH OFFICER post to work with Dr R. S. Basian in a group undertaking molecular and genetic analysis of the chromosomal inactivation and reactivation, and investigating other aspects of mouse development. Successful applicants should have a good Honour degree or equivalent in a relevant discipline.

Experience in mouse genetics, tissue culture and recombinant DNA techniques would be an advantage, but not essential as training will be given. Salary on the appropriate scale. The post carries a £8272-£10 613 (including London weighting) depending on age and experience (pay award pending).

Enquiries may be made to Dr R. S. Basian on 01-864 5311 Ext. 2510. Application forms available from the PERSONNEL DEPARTMENT Ext. 2673 quoting Ref 102/23857. Closing date for applications 22 July, 1988.

The Medical Research Council is an equal opportunity employer.

Cranfield Institute of Technology

School of Industrial Science

(Centre for Molecular Electronics)

RESEARCH ASSISTANT

Applications are invited from Chemistry or Physics graduates for a SERC/CJEC funded research assistantship to investigate the characterisation of hydroxylic polymers as materials for permanent holograms. Suitably qualified candidates would be encouraged to register for a higher degree.

Candidates should have (or expect to gain) a First or Upper Second Class honours degree. The post is for three years commencing 1 October, 1988 and the appointment will be made within the range £8675-£9865 pa. Informal enquiries may be made to Dr F. J. Ashwell, Ext 2324.

Application forms are available from the Personnel Department, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL. Tel Bedford (0234) 750111 quoting reference number NS8118E.

SCIENCE GRADUATES

HELP CREATE THE MARKETS FOR WORLD CLASS PRODUCTS



Agrochemicals

Through innovative research ICI Agrochemicals has become a world leader in the international crop protection business, but before our products can be used it is essential they meet stringent safety standards. Our Regulatory Affairs Section is a vital and expanding part of our operation. It is responsible for the maintenance of the resulting extensive database and the preparation from this of detailed reviews of compounds for presentation to and discussion with government bodies worldwide.

For graduate scientists with a strong commercial awareness it is a highly challenging area which can bring substantial rewards in terms of career prospects and future opportunities for travel either in the UK or overseas.

REGULATORY OFFICER — WESTERN EUROPE

Responsible for evaluating data and making recommendations, usually of a highly technical nature, you will be liaising with a group of Western European countries, acting as the focal point for all registration issues. You will have a broad scientific background with a biochemical bias; knowledge of a second EEC language is also necessary.

REGULATORY OFFICER — MIDDLE EAST & AFRICA

Preparing and monitoring the progress of registration petitions throughout the region, as well as defending existing registrations will require an understanding of scientific and technical data as well as outstanding tact and diplomacy.

PROJECT OFFICER

In this role you will be involved in the programmes designed to assess the safety of pesticides to man. You will also be assisting in the preparation and monitoring of annual toxicology budgets and some practical knowledge/experience of toxicology is required.

Although full training is available both within the Section and on external courses, in each case we look for initiative and a confident and articulate personality coupled with good interpersonal and communication skills and a constructive approach to teamwork.

We offer a highly competitive salary and extensive benefits including pension, profit sharing schemes and a wide range of sports and social facilities at our picturesque setting on the Surrey/Sussex borders.

Please write with full c.v. to: Joe Booth, ICI Agrochemicals Division, Fernhurst, Haslemere, Surrey GU27 3JE.

Closing date for applications: 15th July 1988.

ICI is an equal opportunities employer.

The Medical College of St Bartholomew's Hospital (University of London)

DHSS DEPARTMENT OF TOXICOLOGY

Postgraduate Research Assistant:

Immunocytochemistry in Toxicology

Applications are invited for a 2-4 year Research Assistantship to work with Dr C. Powell on the application of immunostaining in toxicology studies, from September 1988. This project is funded by Glaxo and Shell Research Laboratories and will involve collaborative studies with the sponsoring laboratories on current problems in toxicological pathology, including endocrine abnormalities and drug metabolising enzymes. For an informal discussion of the post, please ring Dr Powell on 601-8612.

Applicants should have a good honours degree in one of the biological sciences and preferably a masters degree in toxicology or experience in histopathology or toxicology. Subject to progress the successful applicant may be allowed to register for a higher degree.

Salary will depend upon age and experience and will be between £7887 and £10 636 pa including London Weighting of £1201. Applications including cv and the names of two academic references should be sent to: The Personnel Dept, The Medical College of St Bartholomew's Hospital, West Smithfield, London EC1A 7BE.

Closing date: 25 July, 1988.

DEPARTMENT OF ENVIRONMENTAL SCIENCES—CHEMISTRY DIVISION

LECTURER IN INORGANIC/ ANALYTICAL CHEMISTRY

Salary: £8481-£15 369 (Starting salary dependent upon qualifications and experience, normally with further advancements to £18 549)

Applications are invited for this established post to teach inorganic and analytical chemistry to students on BSc Hons Applied Chemistry, BSc Hons Environmental Science and other degree courses, and also at HNC/JRSC level. Applicants should have lively and appropriate research interests.

Application forms, to be returned by Friday 29 July, 1988, and further particulars are available from the Personnel Department, Plymouth Polytechnic, at the address below, or by telephoning (0752) 264639.



**Plymouth
Polytechnic**

Drake Circus, Plymouth, Devon PL4 8AA

AN EQUAL OPPORTUNITIES EMPLOYER

EAST HERTFORDSHIRE HEALTH AUTHORITY

Queen Elizabeth II Hospital
Biochemistry Department
JUNIOR/BASIC GRADE MLSO
Required to work in a busy biochemistry department providing a full range of services to the District and also providing some specialist services to neighbouring Districts. The department is automated with on-line data processing and facilities for RIA and general chemical pathology.

Salary is in accordance with Whitley Council rates. JMLS0 1988/89, £5686-£9435 all plus Outer London fringe weighting £149 pa with the opportunity to participate in the on-call rota.

Single person accommodation may be available.

Appointments for informal visits: Mrs B. Fiddick/Dr G. Perrett Tel 0707 328111, Ext. 4454.

Application forms and job descriptions from Personnel Department, Queen Elizabeth II Hospital, Harmer House, Howlands, Welwyn Garden City, Hertfordshire AL7 4HQ.
Closing date 31 July, 1988.

THE QUEEN'S UNIVERSITY OF BELFAST

Department of Biology
RESEARCH ASSISTANT
An Honours graduate with interests in plant physiology and marine biology is required to assist Dr M. J. Diring with a NERC-funded research project on the influence of blue light on the photosynthesis in seaweeds, phytoplankton and aquatic macrophytes, and underwater light quality in lakes and seas around Northern Ireland. The position is available from 1 August 1988 for three years.

Commencing salary: £8976 pa with eligibility for superannuation under USS.

Applicants, quoting Ref 88/H, should submit a cv, including the names and addresses of two referees to the Personnel Officer, The Queen's University of Belfast, Northern Ireland BT7 1NN, from whom further particulars may be obtained. Closing date: 15 July, 1988. The University is an Equal Opportunity Employer.

UNIVERSITY OF CAMBRIDGE Mathematical Modelling in Microwave Remote Sensing

Applications are invited for a POSTGRADUATE RESEARCH ASSISTANTSHIP with the possibility of registering for a PhD. The successful applicant would join a small team studying the use of microwave radiation by vegetation and soil. The main responsibility would be for developing empirical and semi-theoretical models of microwave (5-3 GHz) propagation within inhomogeneous media. Although no botanical or microwave experience is necessary, candidates should have a strong mathematical background.

Applications, with a cv and the names of two referees to Dr M. G. Holmes, Botany School, University of Cambridge, Downing Street, Cambridge CB2 3EA.

THE UNIVERSITY OF LIVERPOOL

Department of Marine Biology
(Port Erin—Isle of Man)
TECHNICIAN GRADE 4

To join the Department's Analytical Laboratory and provide a comprehensive range of Analytical Chemical Techniques for both testing and research.

Applicants should be able to maintain and calibrate instrumentation and experience of Atomic Absorption Spectrophotometers would be an advantage. The minimum qualification required is ONC plus six years' relevant experience.

Informal enquiries to Prof T. Norton (Tel 0624-832027, Ext 142) on the Island.

Salary within the range £7505-£8888 pa.

Quote Ref: PER/874/NS.
Closing date for the above post: Friday, 15 July, 1988.

Application forms available from the Registrar (OAS), The University, PO Box 147, Liverpool L69 3BX.

An Equal Opportunity Employer.

KETERING HEALTH AUTHORITY

TRAINEE MLSO (JUNIOR B)
Salary scale: £4209-£5887

Trainee Medical Laboratory Scientific Officer (Junior B) required to work in the Pathology Laboratories of a busy district general hospital. Vacancies exist in the Blood Transfusion, Microbiology and Immunology departments.

Applicants should possess a suitable science degree or a minimum of two appropriate science 'A' level. The successful applicant will be encouraged to study for further examinations.

For further information or to arrange an informal visit please contact Mr P. A. Blackburn, Senior Chief MSLSO, Tel Kettering (0536) 410077, Ext 229. Application forms and job description from Mr R. A. Crossley, Principal MSLSO, Department of Pathology, Kettering General Hospital, Rothwell Road Kettering, Northants NN16 8UZ.
Closing date: 14 July, 1988.

OXFORDSHIRE HEALTH AUTHORITY

The Churchill Hospital
Department of Medical Genetics
BASIC GRADE BIOCHEMIST

Applications are invited from graduates with an appropriate first or second class honours degree for the post of Scientific Officer (basic grade) in the DNA Laboratory of the above Department. The post is available from 1 October, 1988 and is for one year only. The scientific officer will assist in the prenatal diagnosis and carrier detection of Duchenne Muscular Dystrophy and the presymptomatic testing of Huntington's Chorea. The salary will be in the range of £6993-£9828 depending on qualification and experience.

Applications, with a cv, to Dr J. Jackson, Department of Medical Genetics, Churchill Hospital, Headington, Oxford.

Closing date: (two weeks after date of publication).

UNIVERSITY OF OXFORD

**DEPARTMENT OF
BIOCHEMISTRY**

POSTGRADUATE RESEARCH ASSISTANT

BR/247

A keen graduate Research Assistant (RS 1B Scale) is required to join an active research group as soon as possible. The research, to study at the molecular level effects of peptides on hormonal regulation of cellular metabolism, is designed to increase our understanding of the pathogenesis of several life-threatening diseases.

Applicants should have a strong background in biochemistry or physiology and may be particularly interested in biochemical pharmacology or protein chemistry.

Salary on the scale: £9865-£11 070 pa.

The appointment will be for two years only.

Applications, including two copies of a cv and addresses of two referees should be sent as soon as possible to: The Administrator, Department of Biochemistry, University of Oxford, South Parks Road, Oxford OX1 3QU.

An Equal Opportunity Employer.

UNIVERSITY OF LIVERPOOL Department of Materials Science and Engineering

**POSTDOCTORAL SENIOR
RESEARCH ASSISTANT**

Applications are invited for a Senior Research Assistant to investigate radiation-damage processes in metals by computer simulation. The research is funded by the SERC for three years, and will involve international liaison with other groups using supercomputers for molecular modelling. Applicants should have research experience of condensed-matter theory and computation methods. Initial salary within the range £9865-£11 680 pa.

Applications, together with the names of three referees, should be received not later than 29 July, 1988 by the Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained.

Quote Ref RV/977/NS.

An Equal Opportunity Employer.

UNIVERSITY COLLEGE LONDON

Department of Haematology
The Middlesex Hospital
RESEARCH ASSISTANT

required to continue research into relationship between lymphocyte immunophenotypes, and HIV positivity. The contract will be initially for one year with the possibility of extension for a further year within the salary range of £7887-£9269 pa (inclusive of London weighting) and dependent on age and experience. Closing date for applications, two weeks from appearance of this advertisement. Applications with full cv and the names of two referees to Mr D. F. Barnard, Department of Haematology, The Middlesex Hospital, London W1P 7TP.

Equal Opportunities Employer.

AFCR INSTITUTE OF ARABLE CROPS RESEARCH

**Room's Barn Experimental
Station, Higham,
Bury St Edmunds,
Suffolk IP28 6NP**

Applications are invited for the post of **TEMPORARY SCIENTIFIC OFFICER**.

tenable for four years to study the transmission, multiplication and spread in soil of *Polymyxa betae*, a fungal parasite of sugar-beet roots and vector of beet necrotic yellow vein virus (the cause of rhizomania).

Applicants should have, or expect to obtain in 1988, a first or upper second class honours degree in plant or soil science (or equivalent) and have an interest in plant pathology. The successful candidate will have the opportunity to register for a higher degree.

Salary on scale £2824-£10 622. Non-contributory superannuation.

Application form and further details from the Head of Brown's Barn Experimental Station. Closing date for applications: 15 July, 1988.

An Equal Opportunity Employer.

UNIVERSITY OF CAMBRIDGE Department of Pathology

**Human Molecular
Genetic Research Group**
RESEARCH TECHNICIAN (R6)

Applications are invited for the above post to work on a long term programme, funded initially for five years by the MRC, to study the molecular genetics of the human Y chromosome and its relationship to the X. The work involves the identification, isolation and characterisation of human Y-borne genes including the H-Y gene, genes involved in spermatogenesis and a molecular analysis of the X-linked steroid sulphatase locus.

Qualifications: HNC/Degree in relevant biological science and/or experience in molecular biology and/or cell culture.

Salary: £7145-£8275 (under review).

Applications in writing with names and addresses of two referees to The Superintendent, Department of Pathology, Tennis Court Road, Cambridge CB2 1QP. Please quote FS 9905.

WYE COLLEGE (University of London)

**LECTURER IN AMENITY
HORTICULTURE**

Applications are invited for the post of Lecturer Grade A in Amenity Horticulture at Wye College. The person appointed should have an interest in the propagation and use of ornamental and woody plants, but should be prepared to teach over a wider range of topics in Amenity Horticulture. The salary range of a Grade A Lecturer is £9360-£14 500. Further particulars can be obtained from The Personnel Office, Wye College, (University of London), Wye, Ashford, Kent TN25 5AH. Tel 0233 812401, Ext 228.

Closing date: 22 July, 1988.

Northampton Health Authority
An Equal Opportunities Employer
NORTHAMPTON GENERAL HOSPITAL

JUNIOR B MEDICAL LABORATORY SCIENTIFIC OFFICER IN HISTOPATHOLOGY

is required to work in a busy District General Hospital Histopathology Department, situated in a modern well-equipped laboratory. The Department provides the Histopathology service for the Northampton District and serves a population of approximately 300 000. It has a particular interest in cell markers and is actively looking at computer systems for Histopathology.

Applicants should hold an appropriate degree or two science 'A' levels.

Training for the IMLS professional examinations in cellular pathology will be provided.

The hospital has an excellent social centre. Temporary accommodation may be available.

For further information please contact Mr P. Martin, Principal MLSO, Tel Northampton 34700, Ext 5405. Job Ref AVA 404.

Job description and application form from Mrs K. Adcock, Personnel Department, Northampton General Hospital, Billing Road, Northampton. Tel Northampton 34700, Ext 5770 or Ansaphone 22692.

LECTURER (CONTINUING) IN THE SCHOOL OF PHYSICS

Applications are invited for the above position from experimental physicists with a proven research record and interests which overlap with or complement one of the following fields:
Condensed Matter Physics; Microanalysis applications using the Melbourne Proton Microprobe; X-Ray and Neutron Optics.

Information about the School is obtainable from the Chairman, Professor A. G. Klein, on (03) 344 5420; Fax (03) 347 4783.

Applicants should be willing to participate in the supervision of both honours and postgraduate students. A genuine interest in the undergraduate teaching program is essential.

This position will be available from 1 January, 1989.

Salary in the range: £28 694 to £37 435 pa.

Further information regarding application procedure and conditions of appointment is available from Ms J. Poulson on (03) 344 7448.

Closing date: 30 September, 1988.

Position Number: 640090.

Applications in duplicate including name and addresses of at least three referees and quoting the position number should be addressed to The Director, Personnel Services, The University of Melbourne, Parkville, Victoria, 3052, Australia. An Equal Opportunity Employer.

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Tel: 0256 55955 (24 hours).

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**SOFTWARE ENGINEERS • SYSTEMS ENGINEERS
TECHNICAL PROGRAMMERS • R & D ENGINEERS**

Applicants must be educated to at least degree level, or higher, in Computer Science, Mathematics, Engineering, Physics, or other numerate disciplines. If you have at least one year's experience in any of the following areas we are more than likely to have an exciting position for you.

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SECURE SYSTEMS • TRANSPORTS/OCCAM • ARTIFICIAL
INTELLIGENCE • PARALLEL PROCESSING •
MATHEMATICAL MODELLING • IMAGE PROCESSING • ATE/
SIMULATION • MMI • GRAPHICS • CAD/CAM/CAE •
PROCESS CONTROL/PLC • OPTICS • HOLOGRAPHY**

Salaries will depend on experience and some positions will attract a company car. Generous relocation packages will be offered where appropriate.

Please telephone for an Application Form or write with full details (listing your telephone numbers for contact) to:

**AMES PERSONNEL, AMES HOUSE, KINGS CROSS LANE,
SOUTH NUTFIELD, REDHILL, SURREY RH1 5NG
TELEPHONE: 0737 822122**

AMES PERSONNEL

TECHNICIAN/ RESEARCH OFFICER

To assist research work on the molecular studies of the structure and regulation of an epithelial tumour-associated molecule and the chromosomal abnormalities in breast cancer.

HNC/Degree. Experience of molecular Biology preferred. Salary range £9000 to £12 145.

For Further information and application form please write or telephone Mrs P. Harwood, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2A 3PX on 01 242 0200, Ext 2357 quoting ref 224/R.

Smoking is actively discouraged.

**I M P E R I A L
CANCER RESEARCH FUND**

UNIVERSITY OF SURREY

Robens Institute for Industrial and Environmental Health & Safety

TOXICOLOGY UNIT

Positions are available for—

RESEARCH OFFICER (general toxicology)

RESEARCH OFFICER (in vitro toxicology)

to work on industrially funded research on the safety of chemicals. The positions will suit those who wish for varied and challenging work in an expanding laboratory with excellent career prospects. The positions are initially for one year but with a view to further extensions. Candidates should possess a degree or equivalent in biochemistry or a related subject, or a considerable amount of relevant practical experience.

Appointments will be on the Research and Analogous IB scale up to £10 460 pa, according to age and experience.

For further information please contact Miss Michele Brooks (0432 579212) mentioning the position(s) in which you are interested.

Applications in the form of a cv (three copies) including the names and addresses of two referees should be sent to the Personnel Office (JLC), University of Surrey, Guildford GU2 5XH by 15 July 1988 quoting Ref 718/NS.

LEWISHAM AND NORTH**MARK HEALTH AUTHORITY**

Poisons Unit, New Cross SE14

JUNIOR B MLSO

The Poisons Unit provides a toxicological assay service to Hospitals. Duties will include analysis and measurement of toxic metals and other substances in samples from patients, with suspected poisoning.

You should have two 'A' levels or equivalent which should be in Chemistry and another science subject.

Salary Scale: £5773-£7068 pa (incl).

For application form and job description please contact the Personnel Department, Guy's Hospital, St Thomas Street, London SE1 9RT. Quoting Ref No P/124. Closing date: 15 July, 1988.

ROYAL FREE HOSPITAL**Department of Histopathology (Research)****BASIC GRADE/JUNIOR B MLSO**

£6893-£7887

There is a vacancy for a suitably qualified person to work on research projects in the Department. The post is grant funded for a period of two years. The type of research involves the use of special procedures such as immunocytochemistry and morphometry.

Further details from Mr B. T. Chalk, Senior Chief MLSO. Tel 01-794 0500, Ext 3513.

UNIVERSITY OF GLASGOW**Department of Electronics and Electrical Engineering****NEW LECTURESHIP IN POWER ELECTRONICS**

The Lectureship is intended to support teaching and research in Power Electronics in which new opportunities are arising for exciting application-oriented research. The Lecturer will be expected to develop industrial relations through an existing consortium arrangement (Scottish Power Electronics and Scottish Drives).

Applicants should have experience in either power devices analog/digital real time control, analogue circuit design, electromagnetic engineering or CAD/CAE.

Salary will be on the scale for lecturers within the range £9260-£117 410. Placement will be according to experience and qualifications.

Further particulars may be obtained from the Academic Recruitment Office, University of Glasgow, Glasgow G12 8QQ, with whom applications (eight copies) including the names and addresses of three referees should be lodged by 29 July, 1988.

In reply please quote Ref 5852/3N.

THE UNIVERSITY OF DUNDEE**Department of Biochemical Medicine****RESEARCH ASSISTANTSHIP IN MOLECULAR MEDICINE**

Applications are invited from recent graduates or postgraduates for this vacancy in the laboratory of Professor B. Burchell. Appointment may be made at either research assistant or postdoctoral level.

The successful candidate will be involved in studies on the regulation of expression of UDP-glucuronyltransferase cDNAs and epoxide hydrolases, and their introduction into genetically deficient cells as a model drug-metabolising system. The position is available from 1 October, 1988.

Informal enquiries can be made to Professor Burchell. Tel (0382 23181, Ext 4235).

Applications, with cv (two copies) and the names and addresses of two referees to the Personnel Office, The University, Dundee DD1 4HN. Please quote Ref EST/424/88/NS. Closing date: 14 July, 1988.

UNIVERSITY OF CAMBRIDGE**Department of Zoology****Developmental Genetics****RESEARCH ASSISTANT**

A position is available to join a group working on the genetic and developmental mechanisms of muscle formation in *Drosophila* embryogenesis. The position is funded by the Wellcome Trust and is tenable for three years. Experience with *Drosophila* would be an asset, but appropriate training will be provided.

Salary £8675-£11 680 depending on age and experience.

Send applications, including the names of two referees to: Departmental Secretary, Downing Street, Cambridge CB2 3EJ. Closing date 31 July, 1988.

KING'S COLLEGE LONDON**University of London****Department of Physics****APPOINTMENT OF RESEARCH TECHNOLOGISTS**

Applications are invited for the above appointment which will be available from 1 October, 1988.

The work of the department requires use of national and international research facilities, as the synchrotron and ion beam provision at the SERC Daresbury laboratory, and further synchrotron facilities in Berlin, New York and Grenoble.

The Research Technologist will need appropriate and recent experience of the specification and use of highly sophisticated physical equipment and the ability to handle large projects and large project teams. Initially for the development of X-ray microscopy and related projects using synchrotron radiation.

Salary: £10 125-£13 130 pa or £11 315-£17 170 pa (inclusive of London Allowance) depending on age, qualification and experience.

Further details and application forms may be obtained from: Prof R. E. Budge, Department of Physics, King's College London, Strand, London WC2R 2LS.

UNIVERSITY COLLEGE**HOSPITAL DIVISION****Virology****JUNIOR B MLSO**

£5410-£7068

The Virology Department has a combined service/research responsibility serving two major London teaching hospitals—University College Hospital and the Middlesex Hospital. All aspects of virology are undertaken in this busy department.

You should have two science A levels and would be expected to undertake further formal as well as in-service training.

For an informal discussion contact Mr B. J. Mellars, Chief MLSO on 01-380 9770.

For application form and job description please contact Personnel on 01-380 9699 (24 hour answering service). Please quote Ref GR 01.

Closing date 15 July, 1988.

RIVERSIDE HEALTH**AUTHORITY****Department of Pathology****St Stephen's Hospital****Fulham Road, Chelsea SW10 9TH****MEDICAL LABORATORY****SCIENTIFIC OFFICERS**

Applications are invited for vacancies in the Department of Clinical Pathology in this busy District General Hospital. The Department is well equipped and includes radioimmunoassay and toxicology sections.

For further details please contact Mr R. A. Plant, Senior Chief MLSO. Tel 01-352 8161, Ext 306.

Application forms are available from the Principal Department. Tel 01-352 8161, Ext 535, or 01-725 7027 (24 hours).

Closing date: 16 July, 1988.

KING'S COLLEGE LONDON**University of London****RESEARCH TECHNOLOGICAL****GRADE 3**

Applications are invited for the above position in the Division of Biomedical Sciences to assist in a project concerning the role of proteases in lipoprotein modification in arterial disease. The project will entail mainly tissue culture and biochemical techniques, for which full training will be given.

The post is for two and a half years and is available immediately. It is funded by an MRC grant to Dr David S. Leake, to whom informal enquiries may be made (01-386 5454, Ext 2315).

Applicants should be appropriately qualified with an interest in Biochemistry, Pharmacology or a related subject.

Salary up to £8915 (including London Allowance). Five weeks annual holiday. Superannuation Scheme. Apply in writing, with cv including two references, to Miss C. Crewe, Administrative Assistant (Personnel), Personnel Department, King's College London, Strand, London WC2R 2LS (Quoting Ref No 45569).

UNIVERSITY OF LIVERPOOL**Department of Biochemistry****RESEARCH ASSISTANT**

required to work on an MRC-funded project in the laboratory of the role of novel calcium-binding protein in breast cancer cells. The successful applicant will join an active research group of eight research scientists, the Cancer and Polio Research Fund Laboratories specialising in the study of breast cancer. The post is funded for one year and the salary is £6675. A degree in Biochemistry or a related subject is required and some previous research experience may be an advantage, although this should not prevent well-motivated applicants, taking their first steps on the research ladder, from applying.

Applications, together with the names of three referees, should be received not later than 18 July, 1988 by The Registrar, The University, PO Box 147, Liverpool L69 3BX. Further particulars may be obtained.

Quote Ref RV/978/NS.

An Equal Opportunity Employer.

THE LONDON CHEST**HOSPITAL****Bonner Road, London E2 9JX****Department of Histopathology/Cytology****MLSO/JUNIOR MLSO**

required for his small but busy postgraduate teaching hospital undertaking work in cardiothoracic medicine and surgery. Previous experience desirable but not essential. Applicants should possess two science 'A' levels, one of which should be chemistry, have a science degree or have passed the OTEC.

Further details from Mr T. Buckley, Senior Chief MLSO, Tel 01-880 4433, Ext 232. Application form and job description from the Personnel Office, 100 Bonner Road, address or Tel 01-880 2248 (24 hour answering service). Closing date: 14 July, 1988.

Information Systems for Pharmaceutical R & D

Fisons Pharmaceuticals has a worldwide reputation as an innovator and manufacturer of ethical pharmaceuticals. Research and Development takes place in our purpose-built laboratories on the edge of pleasant rural Leicestershire.

Our Information Systems Team designs, builds and maintains advanced information systems tailored to the needs of our R & D scientists, using DBMS software (System 1032), chemical graphics software (OSAC and ORAC) and other VAX programming facilities. Work with microcomputers is also planned. The team works within the Information Department and also collaborates with information scientists to exploit information technology for the storage, retrieval, packaging and delivery of information to users throughout the Pharmaceutical Division.

We are seeking a computing enthusiast with a degree in a chemical or biological science to join this small, but highly innovative team. Some information science training would also be advantageous. The successful candidate will be able to plan, execute, evaluate and document computing projects; to collaborate with other team members; and to communicate effectively with users (especially scientists) at all levels within the company.

We offer excellent conditions of employment which include profit sharing bonus, flexi-time, 25 days annual holiday plus generous relocation assistance, where applicable, to this attractive and relatively inexpensive part of the country.

Interested applicants should write for an application form to:-

**Mrs. Jane Thompson—Personnel Manager
Fisons plc—Pharmaceutical Division
Research and Development Laboratories
Bakewell Road, Loughborough
Leicestershire
LE11 0RH**

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Preferably located near the M25, Aged 23+. Degree in Biological Sciences. Experience in electrophoresis, DNA sequencing or blotting techniques would be an advantage.

SALARY c £12K

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Preferably located in North Trent or Yorkshire. Age 23+. HNC/BSc in Life Sciences. Experience in haematology, serology or immunology would be an advantage.

SALARY c £11K

SOUTH EAST UK

Preferably located in Sussex, Surrey or Kent. Age 26+. B Sc/HNC in Chemistry. Experience in GC and MS preferable. These vacancies require enthusiastic, hard working applicants with the determination to succeed, good organisational skills and a full driving licence. Phone Irene Fox (South) 01-222 6334/1547 (24hrs) Allison Foster (North) 0742 736471

SALARY c £14K

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77 Great Peter Street,
London SW1P 2EZ

ROSS WARREN RECRUITMENT

KINGSTON POLYTECHNIC

FACULTY OF SCIENCE

Applications are invited for the following NAB funded posts:

SCHOOL OF APPLIED PHYSICS

Research Assistant/ Fellow in Radiation Physics Instrumentation

A graduate with a good honours degree or higher degree and interests or experience in nuclear radiation measurement is required to take a leading role in the development and application of a radioactive materials measurement facility to be used for both research and the provision of industrial services by the School of Applied Physics.

As a member of a small group of nuclear instrumentation physicists with existing research links with the National Physical Laboratory, a suitably qualified candidate will be expected to pursue a programme of research towards a M Phil or PhD.

Please quote Ref. JS384/NS.

SCHOOL OF MATHEMATICS

Research Assistant/ Fellow in Parallel Computing

A graduate with a good honours degree or a higher degree in Mathematics and with a substantial knowledge of Numerical Analysis is required to work on the application of Parallel Computers to Numerical Analysis.

The appointment will be made at either Research Assistant or Research Fellow level depending on qualifications and experience. If a Research Assistant is appointed he/she will pursue a programme of research which will lead to an M Phil/PhD.

Please quote Ref. JS383/NS.

The appointments will be initially for one year: from October 1988, renewable for a further two years. Salary on scale Researcher A/B up to £14 046 p.a. inc. according to qualifications and experience.

For further details and an application form please contact: the Personnel Department, Kingston Polytechnic, Penryn Road, Kingston upon Thames, Surrey KT1 2EE. Telephone 01-549 1366 extension 2153 quoting appropriate reference number. Closing date 11 July 1988.

We are an Equal Opportunities Employer

FRENCH Health Authority FRENCHAY HOSPITAL MEDICAL LABORATORY SCIENTIFIC OFFICER

Basic Grade or Junior B—Histology

Applicants should be state registered with experience in Histology for the MLSO (basic grade) post or hold an appropriate science degree for the Junior B MLSO post.

For further information/visit contact Mr R. Rees, Chief MLSO. Tel (0272) 701212, Ext 2771. Salary for MLSO post commences at £6686 and rises by annual increments to £9435 p.a.

Application form and job description available from the Personnel Department, Frenchay Hospital, Bristol BS1 1LE. Tel Bristol 702000. Closing date for completed applications is 29 July, 1988.

Progress through Learning

Applications are invited from suitably qualified persons regardless of race, sex, colour or national origin for appointment to the following posts:

Department of Botany

Professor

Qualifications: Ph.D.

Requirements: Considerable teaching experience. Assumption of duties: As soon as possible.

Department of Chemistry

Research Associate

Qualifications: M.Sc. in Chemistry.

Requirements: Research experience in at least one of the following: • crystal structure • organic synthesis • natural products • metal complexes • computation. Assumption of duties: As soon as possible.

Additional benefits include payment of removal of furniture and personal effects, assistance towards university education of children, accident insurance cover, study leave, leave gratuities on retirement and membership of group assurance, pension and medical schemes.

Applications should be sent to the Personnel Officer, University of Transkei, Private Bag 11, Umtata, Republic of Transkei. Applicants must furnish their telephone numbers and detailed curriculum vitae as well as full postal addresses of at least three referees.



University of Transkei

SCIENTIFIC TECHNICIAN

ELECTRON MICROSCOPY UNIT

UNIVERSITY OF NEW BRUNSWICK

The University of New Brunswick's Electron Microscopy Unit is looking for a Scientific Technician. The successful candidate will be responsible for the maintenance and operation of the energy dispersive X-ray system of the UNB Electron Microscopy Unit and will carry out qualitative and quantitative analyses of geological, biological, soil and engineering specimens. Duties will be expanded to include wavelength dispersive spectroscopy when this capability is added to the SEM.

Candidates should have a university degree, or equivalent, in the physical sciences. Previous experience with EDS, SEM and WDS is desirable. The successful applicant will receive training as necessary, and may be given the opportunity to work towards an advanced degree involving X-ray microanalysis. The opportunity also exists for collaborative research with faculty from various University departments which may, after a period of time, result in consideration for a higher level appointment.

This position is available immediately. The salary for this position will be dependent upon experience and qualifications. This competition is open until a suitable candidate is found.

Applications should be submitted to:

Department of Personnel Services
University of New Brunswick
PO Box 4400
Fredericton, New Brunswick
E3B 5A3

In accordance with Canadian immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

UNIVERSITY OF NEW BRUNSWICK



LOOKING FOR A START IN MICROBIOLOGY?

c.£8,000

Within ICI Agrochemicals Division, the discovery of novel chemicals produced by micro-organisms is an important area of research.

Our Microbiology Department is currently seeking a keen scientist to join an existing team of Microbiologists and Natural Product Chemists working in this exciting area.

We are interested in candidates looking to start a career in Microbiology, who may have either recently completed a school or college course or who may be wanting to return to a career in science.

We expect applicants to be numerate and dextrous with a minimum of 2 'A' levels (applications will be considered from applicants with Higher Tech certificates and/or ordinary degrees in a related subject).

You will also be able to demonstrate an ability to communicate effectively and to work on your own initiative under pressure.

In-house training will be provided and further education may be continued through part-time study.

We offer a competitive salary with positive career opportunities as well as Company benefits that include profit-sharing, pension fund and a thriving recreation club on a site set in attractive rural surroundings.

Please send your c.v. to: Miss Karen Grant, Recruitment Office, ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berks RG12 6EY. Please quote reference MICROBIOLOGY 5.

Closing date 15th July 1988.

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UNIVERSITY OF STRATHCLYDE STRATHCLYDE INSTITUTE FOR DRUG RESEARCH

The Strathclyde Institute for Drug Research is a new centre formed to conduct interdisciplinary research on drug natural products and agrochemicals. Applications are now invited from suitably qualified candidates for the following positions:

POSTDOCTORAL RESEARCH FELLOW

(Quote Ref: R24/88)

to conduct pharmacological research in the Institute and to perform some teaching duties in the Department of Physiology and Pharmacology. Experience in brain slice or patch clamp recording techniques would be an advantage.

POSTDOCTORAL RESEARCH ASSISTANT

(Quote Ref: R25/88)

to develop some of the Institute's pharmacological screening programmes. Experience in synaptic pharmacology desired.

POSTDOCTORAL RESEARCH ASSISTANT

(Quote Ref: R26/88)

to be responsible for the development and implementation of a data retrieval system for the Institute's compounds and for some research into molecular graphics. A computer literate chemist is required.

The salaries for the above posts will be on the scale £9865-£15 720 pa; all posts are initially for a period of one year.

Applications (quote relevant reference number) with cv and the names and addresses of two referees should be sent to Professor A. Harvey, Strathclyde Institute for Drug Research, University of Strathclyde, Glasgow G1 1XW by 1 August, 1988.

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Life Science Research
ROMA TOXICOLOGY CENTRE S.p.A.

SENIOR ANIMAL TECHNICIANS

Life Science Research - Roma Toxicology Centre, an internationally recognised contract research laboratory, situated 13 miles south of Rome, on the coast, is seeking to fill the following vacancies:

- 1) SENIOR ANIMAL TECHNICIAN DOG UNIT
- 2) SENIOR ANIMAL TECHNICIAN BARRIERED RODENT UNIT

Applicants should have at least four years experience of working with dogs or rodents in toxicology studies performed in compliance with GLP regulations. They should be familiar with all phases of safety studies, preferably using a computer system. A knowledge of the Italian language is desirable but not essential as instruction will be given.

Week-end and Bank Holiday attendance required on a rota basis.

Attractive starting salary. 32 days holiday annually.

Interested applicants should send a cv by special delivery letter to:

Dr N. I. Redmond
Director of Toxicology
Life Science Research
Roma Toxicology Centre
Via Tito Speri, 14
00040 Pomezia
Roma, Italy

PRODUCTION SUPERVISOR PRODUCTION MANAGER DESIGNATE



An opportunity has arisen for someone to join the production team at Unipack, the leading specialists in contract packing of pharmaceuticals.

We are looking for a suitably qualified graduate, Chemist or Pharmacist, with preferably one year's supervisory experience. Candidates should be ambitious and confident in their ability to eventually assume the responsibilities of production manager.

Initially, the need will be to make an immediate and effective contribution to the company's expanding production priorities. Career prospects are excellent for the right person to advance within the company.

Interested applicants should apply in writing giving details of age, qualifications and experience to:

Mr S. Booth, Factory Manager, Unipack Ltd, Bebington Close, Billericay, Essex SS4 1DT.

Clinical Research Associate

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newscientist

LETTERS

Darwin's disciples

Over the past few months I have been amazed by the comments in your magazine about the supposed threat to science from "fundamentalism". Consider, for example, the following, from Beverly Halstead's review of *Confronting Creationism* (16 June, p 72):

"These three lines of attack against Darwinism are very sophisticated, and the combination was sufficient to arouse doubts among intelligent non-scientists, and, it must be conceded, some scientists. Let vigilance be our watchword."

"... no scientist... can afford to be complacent about this issue."

What is this? A logical call to examine the facts and make up your own mind, or an orator's call to arms? If some scientists doubt evolution, listen to their arguments. If they are sound, make the necessary changes to your thinking; if not, show them their error. Whatever you do, do not try to dismiss them by repeating the sacred mantra, "All creationists are Luddite fundamentalists."

I myself am a student of the sciences, and am proud to be heir to a vast body of hard-won information. I am also aware that the scientific method, like all other methods, has limitations. If we ignore these limitations we discredit not only ourselves, but the whole of science. Please do not damage science's good name by asking for blind faith in an unproven and controversial theory, and by crying "foul play" whenever people think for themselves.

Crawford McKelvey
Belfast

Dubious record

In his article "Catch a falling frog" (2 June, p 38), Derek Elson instances cases of showers of marine creatures falling far inland as a result of waterspouts.

I read the item with interest then found myself wondering. If we



assume that such events are no modern phenomenon—and why should they be?—then such showers may have occurred in prehistoric times. The deposited remains would now be part of the fossil record. Might there not be cases where such records are being wrongly interpreted as a result? Where other evidence is lacking, the presence of marine life forms in rock might be taken to imply the actual presence of the sea when in fact we're looking at a nasty case of meteorological skittishness. Just a thought!

P. A. Dean
Pett
East Sussex

Damn foreigners

Don't panic! The "British" educational malaise of the narrow sixth-form curriculum, described in your editorial "The wrong language" (16 June, p 28), is not universal. There are some far-flung corners of the globe where students commonly study five or six subjects to the age of 18. I was educated in one such remote outpost—studying English, maths, chemistry, Latin and Spanish—and had a wide choice of science and arts degrees that I could apply for. I am now a research scientist with ICI and learning other languages with my job.

If Kenneth Baker is interested, he could send a "scouting party" to my homeland to study its methods. If successful, no doubt a "British"

ambassador will follow with countless joint programmes on educational exchange, etc. However, I doubt if Baker has ever heard of this country—Scotland. Geraldine Sweeney
Chesters

In your editorial "The wrong language", you say that "any sixth-former who expresses an interest in studying, say, chemistry and German is treated as an eccentric." But this is to ignore the fact that, as we have shown in our book, *The Growth of Mixed A Levels* (Carnichael Press, 1988), and reported in *New Scientist* (Forum, 20 November 1986, p 68), about 30 per cent of A-level candidates take a combination of science and non-science subjects, a proportion exceeding that specialising in science and mathematics. This can perhaps be interpreted as sixth-form students voting with their feet for the broader curriculum that you advocate.

Alan Smithers
Pamela Robinson
University of Manchester

Guessing game

Your correspondent George Lewis feels that the research showing that girls are "less likely to guess than boys" in a maths multiple choice exam is an "astonishing value judgment" (Letters, 16 June, p 82). In fairness to the "dishonest" boys, a guess may not be a shot in the dark. A boy—and it appears from this research that it is most often a boy—asked, for instance, the product of 7×5 and not knowing the answer, may "guess" that it is a bit more than 5×5 , and look for the multiple choice answer somewhat above 25. Physicists, while away from electronic assistance, use the adult version, the so-called "Ansatz Method", when integrating, for instance—it is simpler to guess an answer, differentiate it and adjust the guess iteratively.

If girls are being trained to miss out questions where they cannot work out the exact answer, then

they are being put at a disadvantage.

I was quite taken by Lewis's own use of logic. "Would I be right to presume," he asks, "that the... researcher... was female? Or... male...?" Yes, you would be right, Mr Lewis. Go to the top of the class with the other boys.
Anne Marsden
London E14

Safety in numbers

I have read more than once recently in the *London Times* about the danger of accidental nuclear war owing to defects in the American defence computer systems.

I have a suggestion to make which may sound like a thought from Ariadne, but isn't meant frivolously.

It seems to me that if there is the possibility of software errors, the Americans (and we British also, if the same problem exists with us) should consider putting the source code of the systems in the public domain. It would then be possible to have a structured walk-through or code-reading sessions on a massive scale. This is the fastest known method of discovering programming bugs.

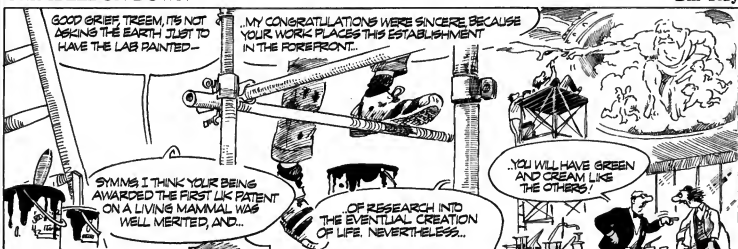
I do not mean that anyone outside the defence establishments should be able to amend the code, or even know the location of the computers. Any interested party with professional programming experience could send a list of tentative amendments, together with the reasons for them, to a PO Box number in London or Washington.

Nicholas McKenna
Runcorn
Cheshire

Wet and dry

Readers may conclude from N. W. Simmonds' letter in praise of tropical tubers (9 June, p 8) that we disagree. We don't. I said in my letter (12 May, p 77) that "they are excellent crops". Simmonds says the same at greater length. My point was that, in Morton Satin's

GRIMBLETON DOWN



LETTERS

article "Bread without wheat" (28 April, p 45), they had been given a partly spurious advantage over seed crops because of the different amounts of water in the products which were weighed in assessing yield.

That source of confusion may still be with us, Omar Sattar (2 June, p 54) claims that *alluca* is a much better crop than potatoes because its tubers contain 10-15 per cent protein, whereas potatoes contain only 2 per cent. I agree that *alluca* is an excellent crop, but the protein content listed must have been measured on its dried tubers, whereas the potato value relates to material as harvested, that is, containing 80 per cent water. When allowance is made for that difference between the materials analysed, their protein contents come out much the same. N. W. Pirie
Harpenden, Hertfordshire

Going private

Your editorial "Hinkley points" (16 June, p 28) suggests that under a privatised Central Electricity Generating Board there might be a different approach to the operation of its nuclear power stations. This is not so.

The board's nuclear facilities are to be vested in the larger of the two generating companies to be formed which will inherit the CEGB's safety culture, expertise and experience as well as its nuclear resources.

Big G, as it is currently known, will be the second largest privately owned generating company in the world. It will continue to devote the same priority to nuclear safety that the CEGB does.

It is incorrect to state that the CEGB has questioned the ability of American utilities to operate nuclear power stations on the grounds that they are privately operated; in fact, there are very good examples of private utilities in the US and elsewhere operating nuclear power stations very successfully. However, considerable backup is required to run nuclear power stations. Big G will inherit the necessary resources from the CEGB and ensure that the board's first-class safety standards are maintained.

Peter Vey
Director of Information and Public Affairs, CEGB
London EC1

Justifiable secrets

Feedback (2 June, p 67) accuses Greenpeace of indulging in "secrecy" over the recent Sellafeld allegations, and suggests that in doing so we are guilty of similar practices to British Nuclear Fuels. There is a difference, however, between secrecy to protect someone's livelihood and career (as had to happen to protect the identities of the Sellafeld workers), and secrecy designed to cover alleged malpractice. We are surprised that Feedback cannot make this distinction.

As to the ocean incineration report, which was criticised in the same column, it is normal practice

to commission scientific reports in which policy implications are not considered. Indeed, most scientists would refuse a brief which included political recommendations. As a campaigning organisation, however, we are entitled to draw our own conclusions from our commissioned research, and that was what we did in this case. It is unfair to imply that duplicity was involved. Allan Thornton
Executive Director
Greenpeace

Talking point

Adherents of the anthropic principle may like to consider the following parable:

Three fire buckets stood outside a golf club. The middle one contained sand. Three ants enjoying a perambulation narrowly escaped disaster when a golf ball suddenly landed in the bucket.

The first ant, having noted the trajectory and velocity of the incoming ball, remarked that it was a superbly aimed shot from a distance of 20 metres. The second retorted that it might have been the one-hundredth attempt by a golfer whose aim was far from superb. The third laughed and



offered the opinion that someone might have put 100 golf balls in a bucket and projected the whole shower of balls at the fire bucket.

It is reported that the three ants eventually expired with exhaustion, each having defended its theory to its last tracheal gasp.

R. H. L. Disney
Department of Zoology
University of Cambridge

Spoons in June

Although I am neither learned nor even a scientist, may I have a stab at answering Eric Starling's question about forks and spoons (Letters, 9 June, p 86)?

Discoloration of forks and spoons depends on two things: (1) What they are made of; (2) What you eat with them. If the implements are made of silver plated with silver, they will discolour if brought into contact with sulphur compounds, which are present in some foods such as eggs and cabbage, not noticeably so in, for example, porridge or custard.

The cure is simple, requiring only boiling water, washing soda and aluminium, as found in a

milk-bottle-top. A handful of soda is dissolved in boiling water and the implement brought into contact with the aluminium bottle-top while submerged. You will see lots of little bubbles being given off from the aluminium (hydrogen?) and the discoloration will miraculously disappear. I believe that what has happened is that the silver/sulphur compound has been converted back into metallic silver. I deduce that Starling eats his eggs poached or fried rather than boiled. Barbara Hutton
Derby

In 40 years of hand-washing cutlery, I have never seen the tips of forks corroding. I have, however, noticed very many bent tips and rough edges to spoons.

From a practical point of view, the corrosion of fork tips could be related to the small individual, abrasive-related spikes—compared to the rounded and less sharp, differently shaped spoons with probably a different top surface depth of metal. Also, one must remember that forks often have to be "scoured" if things such as egg get stuck between the prongs.

There is also the question of what sort of foods you are prodding your forks into. Are they strongly acid or alkaline, and are they different from the food you use your spoon for? (Or do your children use the forks for digging the garden?) Joan Edgington
Penrith, Cumbria

Trees for the chop?

With reference to Christopher Joyce's article "The tree that caused a riot" (18 February, p 54) and Chris Beadle's subsequent letter (21 April, p 69), I would like to point out that a royal instruction has recently been issued to the Sultanate of Oman to the effect that all eucalyptus trees are to be cut down. I wonder if the instruction ordering the wholesale destruction of these trees could, in part at least, have been influenced by your article? While the Omani authorities appear to be acting in good faith, I consider it a rather arbitrary decision, in view of the arguments for and against eucalyptus trees.

As far as I am aware, the trees in Oman do not pose a "problem" due to their relative lack of numbers compared to afforested countries—a case of overreaction? The tree is not used in industry or commercially, being an oil and gas producing nation, it is hardly grown in quantity for cooking fuel. It does help in some small way to stop soil erosion and provide much needed shade in this arid, windswept land. As far as I can tell, most of them are grown purely for enjoyment. If they are thirsty "exotic houseplants" one might as well stop watering all flora in public areas and gardens—they are also "nonproductive" industrially and commercially.

As a nonscientist living and working in Oman, and caring for its environment, for me to see any tree that can gain a foothold and

flourish in this barren land is gratifying. The last thing that Oman should consider is to follow the example of certain South American countries which are destroying their forests. Tom Shaps
Banbury, Oxfordshire

Headless sex



I must protest at the attitude adopted by the authors of "Life and loves of a sexual cannibal" (16 June, p 63). Have people really thought of male mantids as "headless sex maniacs"? Are females "sexual cannibals"? Can females "get the better of a male by signalling her sexual receptivity to obtain an extra meal"?

Surely this sort of misleading language should be avoided in a journal such as *New Scientist*, which is widely read by laymen.

As for the conclusions suggested in the article, having bred the mantid *Heliodora membranacea* for three years, I would suggest that it is rather obvious that a "low-diet" female is more likely to eat the male simply because she's hungry. I would also suggest that the male is little more than a walking meal to the female and the idea that she indulges in vampish behaviour in order to attract him is faintly hilarious.

One final point: "We are largely ignorant about mantid mating habits particularly in the wild." Quite. However, we do know that mantids tend to spread themselves rather sparsely around vegetation due to the fact that relatives are likely to eat them, so could all this talk about "sexual competition" between males be purely academic? Barbara Tomlins
Education Officer
Institute of Biology
London SW7

Cover note

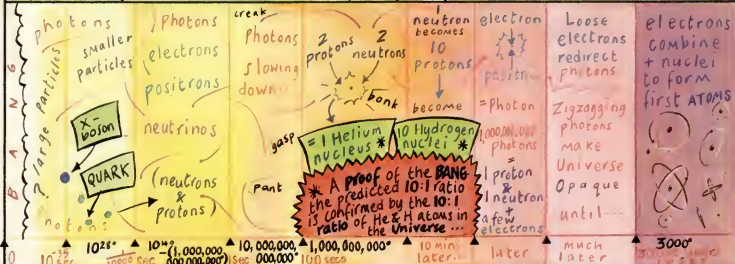
Unfortunately, we omitted to mention in last week's issue that the man pictured on the cover was Vo Quy, dean of biology at the University of Hanoi. Vo Quy, who has played a prominent role in rehabilitating Vietnam's forests, was shown sitting in a war-damaged area in the Mekong Delta, in what Vietnamese scientists refer to as an "Agent Orange museum".

We welcome short communications and reserve the right to edit the longer ones. Write to: Letters to the Editor, *New Scientist*, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG.

Life the Universe & ^{ALMOST} Everything

The BIG BANG! 2

According to theory, the **Universe**, including **Space itself**, sprang from **nothingness** immediately after the **Big Bang**. At once, it began to both **expand** & to **cool down**... And in the **first moments**, it was very, very **busy**...



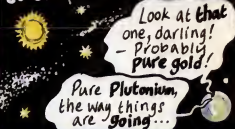
When the Universe cooled to a mere **3000°**, the energy level of the photons fell below that of **matter** - which, together with **Gravity**, has dominated the Universe ever since....



So far, **Gravity** declines to be described by **Quantum Theory**. This is necessary, if the **4 basic forces of nature** (see last week) are to be unified in one **Superforce**. If this can be done, the theory goes, the actual **Moment of Creation** would be revealed & understood...



Elements stopped building after the first **100 seconds**, & the rest of the **Periodic Table** had to wait a billion years to form in the nuclear **cores of stars**...



So the Universe expanded. **Gravity** drew clumps of matter into islands, which became **galaxies** which fragmented into **stars** including, **4,000,000,000 years** ago, on the edge of the **Milky Way**, our **Sun**...

But **some** astronomers favoured the **'Steady State'** theory - in which the Universe **expands** at a **constant rate**, & **Matter** is continuously produced, keeping the **Density** of the Universe constant. Two discoveries soon knocked all this on the head...

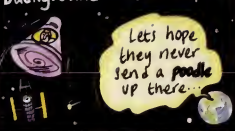


Bleedin' Centaurus A!
-Gerroffoutovit!



It was discovered that there are many more **radio galaxies** at greater distances than at near ones. **Radio waves** from them take **billions of years** to reach us - so to observe them is to observe the Universe under different conditions... & in a different **time**....

The Universe has expanded **1,000 times** since it was **'3000°** hot, so then, when a photon signal from space registered at **3 degrees** above absolute zero - the remnant of the **Big Bang** - the **cosmic microwave background** - had been found.



ARIADNE

I SEE that Relate—the ridiculous new name for the precise and former one of The Marriage Guidance Council—has been carrying on about the strain that commuting may put on marriages. Home comes the commuting man, or woman, and all he or she wants to do is to relax silently in a chair, while the other one, alone all day, wants to talk before, during and after a meal. Relief, strain.

The solution? Well, experts are quoted as suggesting that such a couple should make the most of the little time they have together. Only experts could have thought of such an ingenious and practical idea and the ragged pairs must be grateful for the advice. If this does not work, then the only answer might be, and I assume the same experts are relating like mad to reach it, is, to move nearer to the workplace.

Easier said than done, I reckon, as it's likely that the nearer you get, the higher the price of houses and so on. But worse is to come: Commuting does you no good at all, tests organised by Bart's Hospital in London have shown. Travelling raises heart rate and blood pressure at the start of journeys in either direction. They've got you coming and going, in other words.

About four times a year, on average, revelations such as this appear that mean I can only marvel at the way the human race survives at all. The case of a commuting workaholic (as the saying goes) who smokes, drinks and eats crisps does not bear thinking about.

I have some reservations about these alarms. One is that the picture of a worker coming home and wanting simply to relax, read the paper and not jump into lively converse is far from contemporary. That tableau is as old as work itself. Marriages survived or, doubtless in the words of the experts, the partners managed to relate to each other reasonably well.

Another is this question of the strains of commuting. As it happens, I was travelling on a commuters' train a week or two ago. Nobody seemed to be showing much sign of stress. Opposite me sat a man with earphones who suddenly burst out with "Dove è possibile comprare un giornale?" or some such, when I noticed he had an Italian primer in front of him. He apologised for yelling out what he was learning

via the tape. Next to him a young woman sat who carried out an elaborate make-up routine, lipstick, eye shadow and eyeblick being applied with much use of tiny brushes, baring teeth and grimaces in front of a mirror in the lid of a small case. By craning surreptitiously at the papers my neighbour was working on, I found that he was studying some sort of engineering. Many people were reading papers, others books, some were knitting and some were actually laughing. A friend of mine said that she had seen a woman shelling peas into a colander in a shopping bag. There was no obvious evidence of stress.

Perhaps it is worth repeating that much of the work that people commute to for instance in the City (the Bart's guinea-pig commuter whose blood pressure went up and down—and whose doesn't—worked in the City) could easily be done at home by the use of communications and computer systems that are far from revolutionary nowadays. But then you would not be able to get away from the domestic scene, and that might be too much for your relating strategy. □

ONE computer point leads on to another. I have been impressed to discover that there is in existence integrated creativity software to assist the "poet in everyone". Poetry may be facilitated and enhanced, its originators claim, and then add, a bit mysteriously, "the ultimate word game". The software includes an electronic rhyming dictionary and it will count beats, syllables and feet, all of which items could be rewardingly employed by writers of the so-called lyrics to pop music.

I wonder how flexible the rhyming dictionary is. I am doubtful whether it includes some of the more daring rhymes of, for instance, Lewis Carroll, who produced,

"Who would not give all else for two pennyworth only of beautiful Soup?"

Some years ago, and I forget where, I saw a similar rhyme, used in obvious parody of the well-known and sentimental *Trees*. It ran,

"I think that I shall never see,
a beast as stupid as a shee
p."
but I cannot remember any more of it. □

L AGGING behind as usual, I have only just caught up with the foodstore of the future envisaged by Dan Burchett, until recently Technical Director of Tesco. He let his imagination run free at a conference organised earlier this year by the Foundation for Science and Technology.

I was led into the foodstore of Burchett's imagination by a remark by another speaker at the conference about development, which was "I suggest we will go on eating food". You will have to start at the top of the future foodstore, literally at the top, because it will be a building containing a helical route along which customers will progress in "electromobiles", having parked the children in a crèche and packed off the fit oldsters to the leisure complex, while the unfit or disabled ones, if they want, can shop by computer. So, untrammelled, you will be able to trundle down the helix, a journey which will be more like theatre than the boring shopping we now know. There will be a fish world, salad world, meat or protein world, fresh produce world and even ethnic worlds which, I suppose, mean curly worlds and chop suey worlds and enchilada worlds.

Movement will be one-way, or course, and you will be led through all the departments on your descent to the bottom of the store where you will be able to collect what you bought on the way down without going through a check-out because all the accounting will already have been done.

The theatrical note will be even more insistent, for the various worlds will have demonstrations and tastings going on, with holograms and large screens giving advice and ideas and they will probably be accompanied by delightful, appetising smells.

All the goods on sale will be replenished from the top of the store, thus doing away with transport hold-ups. But there will be no robots doing everything necessary, for people will still value personal service. At all this, reels the brain, as *Time* used to say.

The amazing thing is that by a route of some dubiety, Burchett says that one consequence will be a return to the pleasures of the long dinner party and the art of conversation will return. Maybe. It is my impression that the conversation implied in the phrase seldom, if ever, existed outside the pages of novels. □

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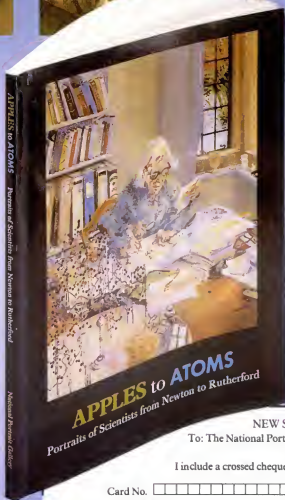
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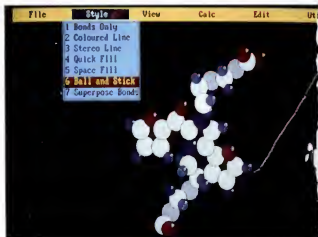
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